HISTORY OF RED LAKES FISHERY, 1917-38, With Observations on Population Status

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EXPLANATORY NOTE

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United States Department of the Interior, Fred A. Seaton, Secretary
Fish and Wildlife Service

HISTORY OF RED LAKES FISHERY, 1917-38, WITH OBSERVATIONS ON POPULATION STATUS

By

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ABSTRACT

A historical account traces the development of the commercial fisheries of the Red Lakes, Minnesota, from its inception in 1917 as a war measure through 1938. The trends of production and catch per unit of effort were followed for the principal species with notes on statistics of the minor fishes. Life history data were recorded for the walleye and yellow perch. A historical account was presented of the artificial propagation of the walleye and whitefish from 1918 through 1938.

NOTE

This report, covering research done in 1938, was completed just before World War II. Because it contains data of historical interest and of value to fishery researchers, it is now being published, particularly in view of the current investigations on the Red Lakes by the University of Minnesota in cooperation with the U. S. Fish and Wildlife Service.

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HISTORY OF RED LAKES FISHERY, 1917-38, WITH OBSERVATIONS ON POPULATION STATUS

The commercial fishing activities of the Red Lake Indians on Lower and Upper Red Lakes, Beltrami and Clearwater Counties, Minnesota, have constituted their principal source of income during several months of each year since the fisheries were established on a continuing basis in 1919. It has been estimated that approximately 1,500 Indians on the reservation depend on fishing for part of their livelihood.

The fisheries, as described in detail later, were first established in 1917 by the State of Minnesota as a food-conservation measure, but later were conducted principally to provide the Indians an additional source of income. In 1929 the State was restrained by a decision of the Minnesota Supreme Court from operating a fishery for profit. Thereafter, the producing and marketing were carried on by an Indian-owned cooperative, The Red Lake Fisheries Association, Incorporated.

It has been assumed by many that the Office of Indian Affairs, U. S. Department of the Interior, and the State of Minnesota have concurrent jurisdiction over the Red Lakes. However, under the Treaty of 1889 the Red Lake Indians ceded the Red Lakes to the United States and not to Minnesota. The State of Minnesota does not have jurisdiction over the fish in the reservation waters of the Red Lakes. Minnesota, however, has the power to regulate the sale and transportation of all fish in non-reservation areas.

This is the report of an investigation which involved actual field work in August and September 1938, and made at the request of the U.S. Commissioner of Indian Affairs. The brief investigation resulted in the accumulation of biological data on the principal species, and a study of all available records and literature afforded an appraisal of the fishery resource, fishing methods and practices.

DESCRIPTION OF THE RED LAKES

Upper and Lower Red Lakes are situated principally in Beltrami County, only the extreme western portion of the lower lake being located in Clearwater County, Minnesota (fig. 1). At least 15 tributaries drain into the lakes, the two largest being the Tamarack River entering Upper Red Lake and the Black Duck River flowing into Lower Red Lake. The outlet is located in Lower Red Lake at the head of the Red Lake River, a branch of the Red River of the North. The lakes, which cover an area of approximately 443 square miles, are situated in the southern part of the Hudson Bay drainage basin. The entire area of Lower Red Lake and 49 percent of the area of Upper Red Lake lie within the boundaries of the Red Lake Indian Reservation.

Upper Red Lake covers an area of approximately 188 square miles or 120,320 acres. A curved line drawn across the lake connecting the reservation boundaries appears to be the official method of separating non-reservation from reservation waters. On the basis of that division 92 square miles (58,880 acres) lie within the reservation and 96 square miles (61,440 acres) outside of the reservation. The total length of shoreline is calculated to be 63.3 miles of which 30.6 miles are within the reservation and 32.7 miles outside. Upper Red Lake has a maximum length of 24.3 miles and a maximum width of 9.8 miles. The lake is connected near its southwestern extremity with Lower Red Lake by means of a navigable channel (called the "Narrows") that has a minimum width of approximately 0.9 mile.

The total surface area of Lower Red Lake is about 255 square miles (163,200 acres) and the shoreline is calculated to be 73 miles in length. The lake has a maximum length of 24.4 miles and a maximum width of 14.5 miles (in the region of the "Narrows").

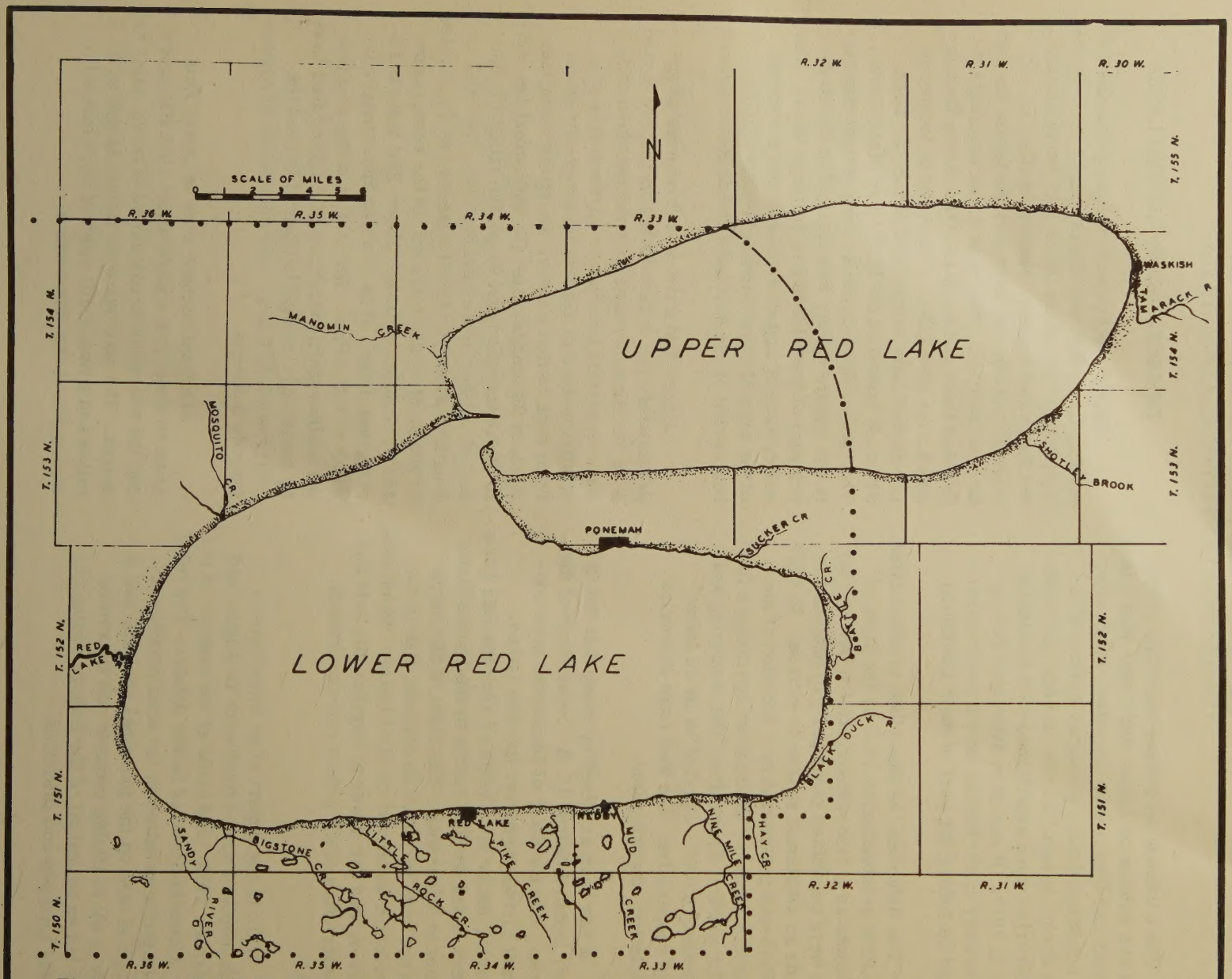

Figure 1.--Map of the Upper and Lower Red Lakes, Beltrami and Clearwater Counties, Minnesota.
The boundary of the Red Lake Indian Reservation is designated by a dot and dash line or by dots.

The Red Lakes are single basin lakes with very regular shorelines virtually without protected bays or coves. (Sisters Bay on Upper Red Lake, east of the "Narrows", is the only prominent bay). The maximum depth of Lower Red Lake was reported to be about 40 feet and the average depth between 20 and 25 feet. The maximum depth of Upper Red Lake was reported to be about 14 to 18 feet with an average of 8 to 10 feet.

The shores of Lower Red Lake and the southern shore of Upper Red Lake are habitable. The northern shore of Upper Red Lake is low and marshy with fairly dense aquatic vegetation and generally is not suited for human habitation. A very small number of white settlers live near the shores of Upper Red Lake, outside of the reservation boundaries. The inhabitants of the shore areas of waters within the reservation boundaries are exclusively Indian.

No hydrographic or limnological surveys have been made of the Red Lakes prior to 1938. Dr. Samuel Eddy of the University of Minnesota made a few observations on Lower Red Lake on August 5 and 6, 1933, which he summarized in a letter as follows: turbidity with Secchi disk, 1 meter; pH (hydrogen-ion concentration) at surface 8.5, at 8 meters 8.0; dissolved oxygen at surface 8.3 p.p.m., at 8 meters 8 p.p.m. Bottom samples were collected but not studied. Dr. Eddy stated that mayfly larvae, Hexagenia, were abundant in the deeper waters. The surface waters of Upper Red Lake contained 5 p.p.m. of free carbon dioxide, 147.5 p.p.m. bicarbonates, and the pH was 8.5 on September 4, 1938. In another letter Dr. Eddy observed: "This lake (Lower Red Lake) is relatively shallow and without any thermal stratification. From my casual observations it seems to be similar to several other lakes which we have surveyed in more detail. These lakes constitute a type which are among our most productive lakes, due to the shallow condition and the fact that the entire bottom is available for food production for fish."

The 1938 investigation entailed no limnological studies.

HISTORY OF THE RED LAKES FISHERIES

The Red Lakes were reported to have been so heavily populated with fish before 1918 that each year vast quantities of various species died and were beached along the shores. The principal species, the walleye Stizostedion vitreum vitreum (Mitchill), was reported to have been small and scrawny ("razor-backed") and the flesh poor. S. A. Selvog (1925?), the first State Superintendent of the Red Lakes fisheries, reported that in 1917 and 1918 these pike "did not compare on the market with the pike from other waters, and averaged scarcely a pound in weight. It is not uncommon now to take pike weighing four to six pounds and frequently more, and a shipping box can be filled with half the number of pike necessary in the beginning..... the quality of fish in Red Lake has been materially improved by the removal of a part of the abundant supply." In an earlier report (1922) he stated, "In 1918 it required from 125 to 137 walleyed pike to fill a box of 150 pounds, whereas during the season of 1922 the number required for the same sized box is from 70 to 85, indicating a marked increase in the average size of the fish. It also appears that during recent seasons dead fish have not been observed in any great numbers around the shores of the lake in the summer time ... ."

Albert C. Klancke (1929), then State Supervisor of Commercial Fishing, wrote, "It has been demonstrated that the taking of the pike, at least, from the waters of Red Lake, has increased the size and quality of the remaining fish. This was realized after a few years of operations."

Prior to the fall of 1917 the only fishing activities on Lower and Upper Red Lakes were conducted by the Indians of the Red Lake Reservation as a source of food. Whitefish and sheepshead for use during the winter were sun dried, or salted and smoked by the majority of the Indian families. The laws of Minnesota at that time prohibited the commercial exploitation of the fishery resources of any of the inland waters of the State.

Economic conditions during the war, the resultant high price of meat and meat products, and the necessity of conserving other food supplies were the principal reasons for the establishment of the commercial fishing industry of the Red Lakes (Avery, 1918). The clamor for a supply of reasonably priced fish as a substitute for meat even led to the unreasonable request that the Minnesota Commissioner of Game and Fish "give the settlers their rights to kill game and catch fish at any time regardless of game laws." The Governor and the Minnesota Public Safety Commission (State War Board) were deluged with similar appeals. At the request of the Public Safety Commission (resolution of September 12, 1917), the Commissioner of Game and Fish formulated a plan for commercial fishing operations and wholesaling in some of the larger inland lakes of Minnesota to be conducted under his supervision.

A commercial fishing enterprise was begun on the Red Lakes during the fall of 1917 with a basic fund of $1,000 appropriated by the Minnesota Public Safety Commission. Because of the lack of equipment there was little commercial fishing during the fall of 1917, but four pound-nets were set off Redby and two off Ponemah in Lower Red Lake in May 1918 by State crews. By the fall of 1918 the State owned 10 pound-nets and 2 gill-nets (Avery, 1919). Collecting stations were established to which the Indians, who fished with hook and line and with gill-nets, and the State pound-net fishermen delivered their catches for sorting, packing, and shipment. The fish were shipped to various points in Minnesota where they were sold by the State at less than the prevailing market prices.

The first pound-net lifted in Lower Red Lake caught 9,657 pounds of fish, approximately 80 percent of which were walleyes. "The fish were found to be so abundant that during May and June (1918) from two to four thousand pounds at a lift were taken from the pound-nets in use." (Avery, 1918). It was reported that in 1918 a gill-net 300 feet long would catch 300 walleyes, and that approximately 1,500 pounds of fish were caught by one Indian in a single lift of 2,000 linear feet of gill-nets. S.A. Selvog (1925?) wrote, "During the war period, this department earned an actual profit of approximately $40,000, due largely to the fact that during the seasons of 1917 and 1918 virtually all the fish produced in Red Lake were taken by our crews and equipment, whereas the fish produced since then has been purchased largely from individual fishermen. There was a loss in 1919 and 1920, but since 1921 the industry has been more than self-sustaining, and no money has been appropriated for its maintenance except the original $1,000 appropriated by the Public Safety Commission in 1917, which was refunded in 1918." In 1918 the majority of the Indians fished with hook and line, but in 1919 they started to use rather extensively, gill-nets of 3-1/2-inch mesh, stretched measure.

Mr. Art Allard, a white man, who was employed almost continuously on the Red Lakes as a spawn-taker by the State during the period 1918-1929, informed us that during the years 1920 to 1922 walleyes taken in pound-nets were sorted for the market. The larger fish, which brought the best prices, ran 40 fish per 100 pounds (average 2-1/2 pounds). At that time pound-netters took no walleyes under 1 pound (sometimes under 1-1/2 pounds) and often sorted the 3-pound and larger individuals (3 to 7 pounds; average about 4 pounds) for the New York market. The walleyes taken in the 3-1/2-inch mesh gill-nets averaged about 1 pound in weight. There was then a fairly good supply of the bigger fish, and in the fall 4- to 7-pound walleyes were plentiful. Large northern pike were also common. The pound-nets were lifted, on the average, every 2 days and never fished uninterruptedly longer than 3 days.

Mr. Allard said the State at first permitted the Indians to employ a 3-1/2-inch mesh, then increased the size to 3-3/4 inches. He said that no dead fish were found around the State's pound-nets, except that occasionally sheepshead ran into the nets in such tremendous numbers that many were killed by the crowding. The small pike were released without apparent harm.

In 1919 it was proposed that the Red Lake fisheries be abandoned, but their continuance was recommended by the Minnesota

Commission of Public Safety and sanctioned by the Legislature in order that some employment might be provided for the Red Lake Indians and for the white settlers on Upper Red Lake outside of the boundaries of the reservation (Klancke, 1929).

The Minnesota State Fisheries of the Red Lakes was established with a revolving fund to be used for state fishing operations, and from 1920 to 1928 inclusive, the State of Minnesota, through its Commissioner of Game and Fish, acted as a distributor and wholesaler of the fish produced. The State continued to fish pound-nets, however, except in certain years as, for example, 1923 and 1924; usually six were in operation but as many as eight or ten had been used. Toward the close of the period of the State's operation and management of the fisheries only four pound-nets were used. The catching of fish by State pound-net crews in competition with the Indian gill-net fishermen was a source of controversy and dissatisfaction.

The Indians fished under a contract between the Commissioner of Indian Affairs, U.S. Department of the Interior, and the State of Minnesota. The first contract, dated April 28, 1921, was renewed June 26, 1923, and January 25, 1924 (for a period of 5 years until January 25, 1929). The 1924 renewal stipulated among other items that the fish should be taken by gill-nets and hook and line, and that the Red Lake Tribe should be paid royalties on all fish purchased from the Indians, and larger amounts for all fish taken by State crews. Each Indian family was limited to 1,500 feet of gill-nets with a mesh of not less than 4 inches, stretched measure, and the annual production from the Red Lakes was limited to 650,000 pounds, exclusive of rough fish (sheepshead, goldeyes, and suckers). (Under the terms of the contract renewal of 1924 the maximum was reduced from 750,000 pounds despite the fact that the Indians had requested an increase of 100,000 pounds in the annual production limit. The reduction reportedly was made because the lake level was 14 inches lower in 1923 than it was in 1922, and it was feared that the walleye population would decrease because of the inability of the spawners to enter the tributary streams). Under this contract fishing was carried on to 1929.

In 1924 a fish hatchery building, a dam and concrete spillway in Mud Creek to provide a water supply for the hatchery, and three cottages for state employees were erected. The total initial cost of these structures was reported to be $40,394.92, all financed by profits from the sale of fish caught in the Red Lakes (typewritten report of Minnesota State Fisheries for the period July 7 to November 15, 1924, dated January 1, 1925). Boats and equipment purchased at the time increased the assets by $7,021.04. No state appropriations were involved in the improvements and purchases.

Although the fishing operations were covered by a contract, there nevertheless developed a number of unsatisfactory features. Not only did the Indians object to the competition of the State pound-net crews, but dissatisfaction also arose concerning the wholesaling operations conducted by the State-appointed manager. The Red Lake Tribal Council passed a resolution on November 20, 1922, which asserted that the State was wantonly wasting the resources of the Red Lakes by refusing to accept and market "rough fish"; that the weighing in of fish caught by the Indians was inaccurate; and that the Indians were not being paid a fair price for their catches. The resolution embodied a plea that the Superintendent of the Red Lake Indian Agency endeavor to find a better market for the Indians' fish, and that he appoint a qualified individual to check the weights of all fish caught by the Indians and delivered to the fishery plant at Redby. Dissatisfaction was also expressed with respect to the late opening (July 1) of the fishing season which forced the Indians to operate at a time when fish were least available.

A check-weigher was appointed by the Superintendent of the Red Lake Agency and a provision for a check-weigher was written into the contract renewal of January 25, 1924. The completion of a cold storage plant and smoke house in 1924 enabled the State to handle the rough fish which formerly were wasted. On May 20, 1925, the Agency Superintendent reported to the Commissioner of Indian Affairs that an investigation of prices paid by private

companies to Minnesota fishermen on the international boundary waters (Lake of the Woods and Rainy Lake) demonstrated that the State of Minnesota underpaid the Indians for their fish.

Controversy arose in 1926 between the state fishery superintendent and the Indian fishermen over the use of illegal nets and consequent destruction of undersized fish.[1/] Many Indians were found (by state inspection, July 1926) to be using 3-1/2-inch mesh and a still larger number were using 3-3/4-inch mesh, although the terms of the contract between the Minnesota Commissioner of Game and Fish and the Commissioner of Indian Affairs specified that a mesh of not less than 4 inches, stretched measure, should be used by all Indians who sold fish to the State. The state fishery superintendent demanded that all illegal nets be turned over to the Red Lake Indian Agency. The agency superintendent affirmed that the Indians could employ whatever net mesh they chose in taking fish for their own consumption, but that all Indians would be informed that fish caught with illegal nets could not be sold to the State. Apparently, the superintendent of the fisheries was not satisfied with this decision for he refused to buy fish from Indians who had illegal nets in possession, as determined by an inspection made by one of his employees.

State Supervisor, Albert C. Klancke (1929), expressed the State's views in regard to the method of fishing by the Indians as follows: "The method of taking (fish), however, does not commend itself. Gill nets are used almost exclusively, and unless utmost diligence is exercised, the marketable condition (of the fish) is not the best. Hence, Red Lake fish do not command the price usually paid for pound net catches. Weather conditions on Red Lake often preclude the taking of fish at desired periods, with the result that at times more fish are produced than can properly be taken care of at the fishery plant and for which a desirable market can be found. These matters can, however, be properly regulated when the fishermen themselves realize that it is to their advantage to strictly adhere to the fishing regulations and an effort made to deliver the fish in the best possible condition. It is to be hoped that in the near future only pound nets will be utilized, thus assuring an even run of fish, better in size and condition, and when the market commands the best prices." Later (1931) he wrote: "It has been urged that the use of gill nets in taking the catch should be done away with. The use of pound nets should be substituted, for by the use of such equipment production can be controlled, and better prices obtained for the catch, with the assurance that the quality will be the highest."

At the time of the 1938 investigation gill nets were set and lifted by hand, usually from a row boat. Except when a storm prevented lifting, all nets fished one night out, being set in the late afternoon or early evening and lifted early the next morning. The nets were cleared on shore except the whitefish gill-nets operated in the fall, which were cleared when lifted so that the nets could be reset. Most of the fishing was done within 1-1/2 or 2 miles from shore, although some nets were set as far as 4 or 5 miles offshore. In spring and early summer when the water is cold the fish are near the shore but as the water warms they move into deeper water (20 to 40 feet) so that the nets are set farthest from shore during the warm season. In order to obtain fish for home consumption some Indians operated gill nets through the ice and many continued to use all of their gill nets after the summer season for commercial fishing had been closed.

The legal right of the State of Minnesota to conduct a wholesale fish business for private profit in competition with private industry was challenged in a summons and complaint served on the Commissioner of Game and Fish of Min-

1/ In the Bemidji (Minn.) Sentinel of February, 1927, the State Superintendent wrote: "The last season, 1926, was the most deplorable situation of all the years I had charge of that industry (since 1917). There were thousands of little pike produced that had not attained a length of more than seven or eight inches, thousands of pike were delivered to us of this size and what was delivered to us was only a drop in the bucket of what they left to rot at home, or at their fishing stations ... ."

nesota on May 31, 1927, at the instigation of a licenced wholesaler and buyer of fish at Winona, Minnesota. The Attorney General of the State of Minnesota interposed a demurrer to the complaint, which demurrer was overruled by the District Court of Ramsey County. The case was then appealed to the State Supreme Court whose decision (February 17, 1928) upheld the action of the lower court which, then, on January 14, 1929 issued an order that restrained the State from engaging in the commercial buying of fish in competition with private industry.

Shortly after the issuance of this order the Minnesota Legislature passed an act (Act, March 22, 1929, Chapter 84) authorizing the Commissioner of Game and Fish to lease the Red Lakes fishery plant to the United States or its authorized agency. This act is the legal basis on which the Red Lake Fisheries Association has operated and it is given here verbatim. Section 5592, subsections 1-8, of the Laws of 1929 follow:

"5592-1. Fish may be taken and sold from certain lakes.--Whenever the commissioner of game and fish shall find after investigation that any kind or kinds of fish may be taken from Upper Red Lake in Beltrami county or from Lower Red Lake in Beltrami and Clearwater counties, or from any part of said lakes, without unduly depleting such fish therein, he may, so long as such condition shall continue, permit such fish to be taken in said lakes or in such part thereof as he may designate, in such manner as he may deem proper, and may permit such fish to be possessed, transported, sold, or otherwise disposed of; such taking, possession, transportation, sale, or other disposition to be under the supervision of the commissioner and subject to such regulations as he may prescribe, and subject to suspension or termination at any time as to any kind of fish whenever the commissioner shall find that such fish cannot be taken without unduly depleting the same. [Retained without change in Laws of 1939, art. 44.]

"5592-2. Commissioner to make regulations.--The commissioner is hereby empowered to make all needful and proper regulations for the purposes of this act, and to require persons taking, possessing, transporting, selling, or otherwise disposing of such fish to obtain licenses and to pay such license fees or other charges as he deems proper to defray the cost of administration and enforcement of this act and to contribute toward the expense of conservation and propagation of fish in said lakes. [Retained without change in Laws of 1939, art. 45.]

"5592-3. Violation a misdemeanor.--Violation of any regulation prescribed by the commissioner under this act shall be deemed a violation of this act, and shall be a misdemeanor. [Deleted in Laws of 1939.]

"5592-4. Restriction.--No fish shall be taken from the portion of said lakes within the Red Lake Indian reservation in violation of any law or regulation relating thereto prescribed by or under the authority of the United States, and all regulations made by the commissioner of game and fish under this act relating to the taking of fish from said Indian reservation waters shall be made subject to compliance with such federal laws and regulations. [Retained without change in Laws of 1939, art. 244.]

"5592-5. Commissioner may lease plant and equipment.--The commissioner of game and fish is hereby authorized to lease the state fisheries plant and equipment at Redby to the United States or to any proper authorized agency thereof for such term or terms from time to time and upon such conditions as to rental and otherwise as he shall deem reasonable, subject to termination by direction of the legislature at any time, provided, that such plant and equipment shall be used only for the benefit of the Indians and other persons taking fish from said lake in accordance with the provisions of this act. The commissioner is also authorized to lease the state fish hatchery and equipment at Redby to the United States or to any proper authorized agency thereof upon like terms and conditions and subject to termination in like manner provided that said hatchery shall be operated only for the propagation of fish in said lakes or such other waters of the state of Minnesota as the commissioner may designate; or the commissioner may, in his discretion, continue to operate said hatchery. [Retained without change in Laws of 1939, art. 46.]

"5592-6. Disposition of fees.--

All fees and rentals under this act shall be paid to the commissioner of game and fish and shall by him be transmitted to the state treasurer, who shall credit the same to the state fish revolving fund constituted under the provisions of General Statutes 1923, Section 5604, and acts amendatory thereof and supplementary thereto. In addition to the purposes prescribed by said Section 5604, all moneys in said funds shall hereafter be available to pay the cost of administration and enforcement of this act and the cost of propagation and conservation of fish in said lakes, and said moneys are hereby appropriated therefor so far as may be necessary. Said Section 5604 is hereby modified and amended, so far as inconsistent herewith, so as to conform herewith. [Retained without change in Laws of 1939, art. 76.]

"5592-7. Acts subject to penalty and forfeitures of other acts.--This act shall be part of the laws relating to wild animals, and violations thereof shall be subject to the same penalties and forfeitures as prescribed for violations of such laws. [Retained without change in Laws of 1939, art. 331.]

"5592-8. Acts supplementary.--This act shall be supplementary to all other laws applicable to the taking or disposition of fish from said lakes, and shall not be deemed to repeal or supersede any such other law except so far as directly inconsistent herewith." [Deleted in Laws of 1939.]

On March 27, 1929, shortly after the enactment of the above legislation, the Red Lake Fisheries Association was organized and incorporated under the laws of Minnesota by the Red Lake Tribe, in order that the commercial fisheries of the Red Lakes might be exploited judiciously and profitably by the Indians.

The Commissioner of Indian Affairs, U. S. Department of the Interior, authorized the Red Lake Indians to engage in commercial fishing on the waters of the Red Lakes within the boundaries of the reservation and accorded official sanction to the Red Lake Fisheries Association. An agreement was reached between the Association and the Minnesota Game and Fish Commissioner whereby a lease was entered into for a period of 5 years from 1929. Fishing operations were started in July 1929 and continued until November in that year.

Not only did the Minnesota Commissioner of Game and Fish grant the Association a lease for the use of the fishery plant and equipment but, according to Klancke (1931), he also agreed to use the accumulated balance of some $27,000 in the State Fish Revolving Fund for the care and maintenance of the fishery plant.

Upon recommendation of the Superintendent of the Red Lake Agency, the Commissioner issued regulations that governed the taking of fish and the conduct of the business of the Association. The rules and regulations, promulgated under date of March 10, 1930, were:

"It appearing that commercial fishing profitably may be done in the waters of the Red Lakes, on the Red Lake Indian Reservation, in the State of Minnesota, and certain Indians of said reservation having heretofore organized and incorporated the Red Lake Fisheries Association under the laws of the State of Minnesota for the purpose of engaging in the business of producing and marketing fish, and the Red Lake Reservation being an unceded, unallotted Indian Reservation under the exclusive jurisdiction and control of the United States, authority is hereby granted said association to do commercial fishing in the waters of the Red Lakes on said reservation and to engage in said business only in accordance with the rules and regulations hereinafter contained: Provided, That said association is recognized only as an instrumentality of the United States for the purpose of doing said fishing and conducting said business in the interest of said Indians; And Provided Further, That the United States does not surrender, relinquish, or modify its exclusive jurisdiction and control over the Red Lake Reservation, the Red Lake Indians or their property, or concede or acknowledge any right, power, or authority of the State of Minnesota, its courts or officials, or said association or any other agency, to in any way supervise, control, or administer the affairs of said reservation or said Indians or their property; And Provided Further, That the authority hereby granted to engage in said business may at any time be cancelled and withdrawn, and the following rules and regulations likewise may be

modified or amended:

RULES AND REGULATIONS

"1. Fish may be taken from the waters of Upper and Lower Red Lakes, on the Red Lake Indian Reservation, in Minnesota, during the period from May 15 to November 15 in any year only by the Indians duly enrolled and belonging on said reservation. Said Indians may become members of, and market their fish through, the Red Lake Fisheries Association. All fishing operations for commercial purposes may be suspended at any time by order of the superintendent of said reservation.

"2. The association is hereby authorized to take from the State of Minnesota a lease on the fisheries plant and hatchery at Redby, Minnesota, or either of them; but the terms and conditions of such lease shall be subject to the approval of the Commissioner of Indian Affairs.

"3. Application for membership in the Association must be submitted to, and approved by, the board of directors. A certificate of membership shall be issued to members; but no membership fee, license, or charge shall be required of applicants.

"4. The by-laws of the association shall conform to these rules and regulations, and such changes or amendments as hereafter may be made. Any member who shall fail to comply with these rules and regulations may be expelled from membership by the superintendent of the reservation, and any member who shall fail to comply with the by-laws of the association may be expelled by a majority vote of the members present and voting.

"5. (a) Fish may be taken for commercial purposes only by members of the association: Provided, however, That any Indian duly enrolled and belonging on said reservation may take fish at any time for his own use, and may sell fish taken by him (1) to other Indians of the reservation, (2) to licensed traders on the reservation for the purpose of resale to Indians, and (3) to white citizens during the open season, in such quantities, of the size and varieties as may be taken with hook and line, transported and possessed by white citizens as provided by the laws of the State of Minnesota.

"(b) No Indian shall sell fish in any quantity outside the reservation, except in accordance with the laws of the State of Minnesota.

"(c) No Indian shall take a variety of fish during its spawning season, except for propagation purposes.

"(d) Any Indian violating the provisions of this section shall forfeit his membership in the association and his right to take fish for any purpose for a period of three months.

"6. The board of directors of the association shall employ a manager, selected by the Commissioner of Game and Fish of the State of Minnesota, and such other help as may be necessary; and they shall have the power to fix the compensation of persons thus employed.

"7. The manager shall have the general supervision of the business of the association. He shall direct the production, sorting, packing, transportation, and sale of fish and other products handled by the association, the time of fishing, the quantity, kind, and size of fish to be taken and the method of taking same; subject, however, to the superior supervision and control of the Commissioner of Indian Affairs.

"8. The manager and any other employee or officer of the association who has custody or control of the receipts and disbursements of the association shall be required to give a surety bond in the sum of not less than $10,000.

"9. Books and records of the business of the association shall be kept showing all receipts and disbursements, the names and addresses of all persons from whom fish are purchased and to whom fish are sold, and all other transactions of the association; and such books and records shall at all times be open to inspection by the superintendent of the Red Lake Reservation or his duly authorized agent.

"10. The board of directors shall examine all accounts at their regular monthly meetings and shall have the books of the association audited at least once a year,

such audit to take place during the thirty days preceding the annual meeting and a full and complete report of such audit shall be made to the superintendent of the reservation on or before the date of the annual meeting.

"11. Members shall be paid bi-weekly for the fish purchased from them by the association, the price to be determined by the manager and to be such as to insure the payment of (a) and (b) of this section. The proceeds of the business shall constitute a fund which shall be distributed as follows:

"(a) Current operating and maintenance expenses shall be paid.

"(b) Five percent of the gross receipts from the fish purchased by the association from its members shall be paid into the Treasury of the United States, to be credited to the tribal funds of the Red Lake Indians.

"(c) A certain percentage to be determined by the board of directors of the association shall be set aside for an operating capital.

"(d) After making the above deductions the remaining amount shall be paid at least annually to the members on a patronage basis, to be determined by the board of directors from the quantity and kind of fish purchased by the association from its respective members.

"12. All receipts from the sale of fish taken from waters on the Red Lake Reservation shall be trust funds, subject to the control of the Commissioner of Indian Affairs, and shall be distributed as provided in section 11 hereof till otherwise directed by a modification or amendment of these rules and regulations.

"13. The funds of the association shall be kept in a depository selected by the board of directors, and withdrawn only on vouchers signed by the secretary-treasurer and countersigned by the manager.

"14. All marketable fish must be delivered in good condition to the association at its place of business at Redby, Minnesota. All unmarketable live fish must be returned to the waters, and all unmarketable dead fish must be buried by the person taking same.

"15. A total of not to exceed 650,000 pounds of fish may be taken in any one season, exclusive of rough fish and fish taken for propagation purposes.

"16. (a) Any variety of fish may be taken by Indians from any of the waters on the Red Lake Reservation by hook and line; and from Upper and Lower Red Lakes by gill nets, pound nets, or trap nets.

"(b) Each member of the association shall be limited to five gill nets of 300 feet in length and 6 feet in depth.

"(c) Gill nets for taking pike shall have a mesh of not less than 3-3/4 inches extension measure.

"(d) Gill nets for taking whitefish shall have a mesh of not less than 5-1/2 inches extension measure.

"(e) Pound nets may be used for taking fish for propagation purposes.

"(f) Trap nets in accordance with the specifications and directions of the manager may be used for taking fish of any variety.

"17. Each Indian family shall be limited to one membership in the association, but single male Indians over twenty-one years of age shall be entitled to a membership."

The principal terms of the 1929 lease that entitled the Red Lake Fisheries Association to use the fishery building and equipment at Redby were as follows:

1. A conveyance of the lease to the Commissioner of Game and Fish of Minnesota of lands owned by the Minneapolis, Red Lake, and Manitoba Railway Company, situated near the town of Redby, Minnesota, at the mouth of Mud Creek on the south shore of Lower Red Lake.

2. The fishery buildings, dock, and all equipment were leased with the provision that the Association assume the cost of maintenance,

repairs and replacements.

This lease was renewed July 1, 1933 for a period of one year. At the insistence of the State, which demanded a rental for the Red Lake hatchery, the lease of July 1, 1934 also provided that the Red Lake Fisheries Association pay one-half of the annual salaries of two hatchery employees and assume one-third of the operating expenses of the hatchery, the total of such expenses not to exceed $4,000.00. Although previous agreements made no reference to hatchery expenses the Association had paid one-half of the annual salaries of two employees since 1929. Again at the request of the State the rental was increased and the lease of July 1, 1935 raised the Association's share of the operating expenses from one-third to five-eighths. These terms were not changed in subsequent leases.

EVENTS THAT LED TO THE 1938 INVESTIGATION

The Red Lake Fisheries Association felt that it was forced, by the terms of the 1935 contract with the Minnesota Conservation Commission, to assume too great a share of the operating expense of the hatchery. From 1929 to 1933, inclusive, the Association paid the State a total of $7,080 or an average of $1,416 per year. From July 1, 1934 to December 31, 1938 it paid a total of $15,994 or an average of $3,199 per year. During the entire 10-year period the total amounted to $23,074 or an average of $2,307 per annum. It has been estimated (by a state employee) that the actual average cost to operate the hatchery from 1929 to 1933 was $4,895 per year. The second biennial report of the Minnesota Department of Conservation for the fiscal years, 1933-1934, page 169, states: "The cost to the State of operating the hatchery and fisheries plant is approximately $4,400 per year, a cost entirely out of proportion to the benefit the state receives in return." The third biennial report for the fiscal years, 1935-1936, page 154, lists the following expenditures for the Redby hatchery and field station: 1934-35, $3,189.81; 1935-36, $2,448.35.

The contract between the State and the Commissioner of Indian Affairs expired July 1, 1938, and was not renewed because under the proposed terms of the new contract the Minnesota Department of Conservation called for a rental of $6,500 per year.

Various controversies between the State, political groups, anglers, and the Indians led to a field investigation extending from August 23 to September 10 in 1938, and an analysis of records by the authors.

FISHES OF THE RED LAKES

A complete list of fishes known or reported to occur in the Red Lakes or in or near the mouths of their tributaries in 1938 is given in table 1. Species reported by Surber (1920) or observed by us in the commercial catch or recorded in the statistics are designated by Xs. The actual number of individuals of each species captured is given for the seining localities.

The list of fishes occurring in the Red Lakes or the tributary stream, Mud Creek, comprised 30 species (two species represented by the hybrid, No. 26) distributed among 14 families. As indicated in a footnote to the table, there was good reason to doubt the actual presence of the mooneye; consequently the number of known species at that time should be given as 29. Of this number only 10 were reported by Surber (1920). The species for which first records of occurrence in the Red Lakes were made in 1938 are given in table 1 and are distributed according to family as follows: Catostomidae, 1; Cyprinidae, 8; Esocidae, 1; Percopsidae, 1; Gasterosteidae, 1; Percidae, 1; Etheostomidae, 3; Centrarchidae, 3.

Table 1.--Species of fish reported from the Red Lakes by Surber (1920) and observed or collected by authors. (Occurrence of fish reported by Surber or observed in commercial catch indicated by X)

Family and scientific name	Common name	Reported by Surber (1920)	Observed by authors in commercial catch	Number taken by seining in locality						Standard length in millimeters of specimens taken with seine
				Northeast corner, Upper Red Lake	Mouth of Tamarack River, Upper Red Lake	Mouth of Black Duck River, Lower Red Lake	Redby, Lower Red Lake	Mud Creek, Lower Red Lake: Upstream 500 feet	Mud Creek, Lower Red Lake: Upstream 1,000 feet	
Acipenseridae										
1. Acipenser fulvescens Rafinesque[1/]	Lake sturgeon	X	—	—	—	—	—	—	—	—
Hiodontidae										
2. Amphiodon alosoides Rafinesque	Goldeye	X	X	—	—	—	—	—	—	—
3. Hiodon tergisus Le Sueur[2/]	Mooneye	X	—	—	—	—	—	—	—	—
Coregonidae										
4. Coregonus clupeaformis (Mitchill)[3/]	Common whitefish	X	X	—	—	—	—	—	—	—
Catostomidae										
5. Carpiodes cyprinus (Le Sueur)[4/]	Carp sucker, quillback	X	X	—	—	—	—	—	—	—
6. Catostomus c. commersonni (Lacépède)	White sucker	X	X	—	—	—	—	1	22	(55) 88-162
7. Moxostoma aureolum (Le Sueur)	Redhorse sucker	—	X	—	—	—	—	1	15	39-82
Cyprinidae										
8. Notemigonus crysoleucas auratus (Rafinesque)	Western golden shiner	—	—	—	1	—	—	—	—	29
9. Semotilus a. atromaculatus (Mitchill)	Creek chub, horned dace	—	—	—	—	—	—	4	3	39-67; 83-112 (1,000 ft.)
10. Rhinichthys atratulus meleagris Agassiz	Western black-nosed dace	—	—	—	—	—	—	5	—	31-48
11. Notropis v. volucellus (Cope)	Mimic shiner	—	—	—	—	—	—	2	—	33-36
12. Notropis heterodon (Cope)	Black-chinned shiner	—	—	—	1	—	—	—	—	27
13. Notropis hudsonius selene (Jordan)	Northwestern spottailed shiner	—	—	1	26	—	2	—	—	24-42(Upper); 72-77(Lower)
14. Notropis cornutus frontalis (Agassiz)	Northern common shiner	—	—	—	—	—	—	1	11	(49) 60-122
15. Pimephales p. promelas Rafinesque	Fat-head minnow	—	—	5	24	—	—	5	—	19-49
Ameiuridae										
16. Ameiurus nebulosus (Le Sueur)	Brown bullhead	—	X	—	—	—	—	—	—	—
Esocidae										
17. Esox lucius Linnaeus	Northern pike	—	X	—	—	1	—	—	—	157
Percopsidae										
18. Percopsis omiscomaycus (Walbaum)	Trout perch	—	—	—	—	—	—	1	—	55
Gasterosteidae										
19. Eucalia inconstans (Kirtland)	Brook stickleback	—	—	—	—	—	—	3	—	32-37
Gadidae										
20. Lota maculosa (Le Sueur)	Burbot, lawyer	X	—	—	—	—	—	—	—	—
Percidae										
21. Perca flavescens (Mitchill)	Yellow perch	—	X	1	2	—	19	3	12	46-62;56-148(1,000 ft.)
22. Stizostedion v. vitreum (Mitchill)	Walleye	X	X	—	—	—	—	—	—	—
Etheostomidae										
23. Boleosoma nigrum eulepis (Hubbs and Green)	Scaly johnny darter	—	—	1	1	—	2	5	1	28-36
24. Hadropterus maculatus (Girard)	Black-sided darter	—	—	—	—	—	—	1	—	34
25. Poecilichthys exilis (Girard)	Iowa darter	—	—	—	—	6	2	22	7	25-36
Centrarchidae										
26. Lepomis gibbosus (Linnaeus)[5/]	Common sunfish	—	—	—	—	—	—	—	1	97
26. Lepomis cyanellus (Rafinesque)[5/]	Green sunfish	—	—	—	—	—	—	—		
27. Ambloplites rupestris (Rafinesque)	Rock bass	—	X	—	—	—	—	—	—	—
28. Pomoxis sparoides (Lacépède)	Black crappie	X	—	—	—	—	—	—	—	—
Sciaenidae										
29. Aplodinotus grunniens Rafinesque	Freshwater drum	X	X	—	—	—	—	—	—	—

1/ Reported by Surber as A. rubicundus Le Sueur.

2/ Reported by Surber as possibly the most common form; may have been confused by Surber with the goldeye.

3/ Reported by Surber as C. labradoricus Richardson.

4/ Reported by Surber as C. thompsoni Agassiz.

5/ Represented by the hybrid, common sunfish x green sunfish.

Table 2.--Annual production in pounds by species of the Red Lakes fisheries during 1917 to 1938, inclusive, and value of total yield to fishermen, including the royalties and bonuses.

Year[1]	All species	Walleyes	Yellow perch[2]	White-fish	Northern pike[2]	Freshwater drum[2]	Gold-eyes[2]	Suckers[2]	White carp[2]	Bull-heads[2]	Sturgeon	Culls, under-sized fish, and rough fish	Value
[3] 1917-1918	[4] 825,446	356,023	756	190,878	29,998	69,119	67,552	78,289	30,016	1,948	785	-	-
1918	[5] 538,644	-	-	-	-	-	-	-	-	-	-	-	-
1919	-	-	-	--	-	-	-	-	-	-	-	-	-
1920	322,684	186,751	-	39,463	-	-	-	-	-	-	293	96,177	$29,431
1921	645,357	500,279	12,108	64,235	-	-	-	-	-	-	92	68,643	41,013
1922	838,162	744,376	16,994	18,444	-	-	-	-	-	-	-	58,348	80,410
1923	715,952	523,297	30,875	114,975	26,611	-	-	-	-	-	-	20,194	69,256
1924	959,614	743,092	19,046	82,765	60,869	-	-	-	-	-	-	53,842	65,054
1925	[5] 931,750	-	-	-	-	-	-	-	-	-	-	-	50,639
1926	855,055	610,024	60,379	9,726	29,375	-	-	-	-	-	-	145,551	55,996
1927	792,452	547,325	109,267	52,564	15,645	14,133	52,077	847	3	591	-	-	63,918
1928	720,455	503,093	69,113	85,574	23,452	7,696	25,151	5,602	160	614	-	-	70,816
1929	1,086,473	694,879	137,469	134,850	61,087	11,579	19,542	25,026	344	488	-	1,209	99,931
1930	746,862	453,431	76,963	117,280	42,049	17,601	26,393	11,612	758	775	-	-	57,003
1931	1,061,837	746,215	96,109	142,581	32,364	22,741	2,635	8,166	-	1,046	-	9,980	51,773
1932	983,546	651,699	153,542	132,716	28,177	14,524	1,890	-	-	686	-	312	33,094
1933	783,373	542,056	183,063	28,283	13,232	14,880	362	761	-	736	-	-	31,993
1934	866,953	502,832	170,138	126,227	25,750	17,719	22,346	1,147	-	794	-	-	32,770
1935	721,419	359,206	167,842	47,826	9,222	25,937	101,770	8,906	-	710	-	-	19,190
1936	757,217	308,185	116,497	26,131	13,781	42,733	247,383	2,104	-	403	-	-	20,293
1937	1,018,225	614,220	237,561	38,874	12,075	18,624	96,715	-	-	156	-	-	33,660
1938	1,061,014	682,343	230,863	14,816	19,736	14,949	98,247	-	-	60	-	-	36,990
Average, 1927-1938	883,317	550,457	145,702	78,977	24,714	18,592	57,876	5,348	105	588	-	958	$45,953
Percentage	100.0	62.3	16.5	8.9	2.8	2.1	6.6	0.6	0.0	0.1	-	0.1	

1/ For the years, 1918-1926, inclusive, totals are for the fiscal year beginning July 1 of the year previous to that listed. Other figures are for calendar years.

2/ Included in cull and rough fish totals in some years.

3/ October 15, 1917-December 31, 1918.

4/ Includes 39 pounds of rock bass and 43-1/2 pounds of caviar.

5/ Data for individual species not available.

STATISTICS OF THE RED LAKES FISHERIES

Total yield and value

Practically complete data are available on the total production of the Red Lakes fisheries since commercial fishing began in 1917 (table 2). Catch statistics are lacking only for the first six months of 1919 and the last six months of 1926. The total production from the beginning of the fishery through 1938, exclusive of the catch in these 2 half-year periods, was 16,693,210 pounds. Had complete data been available the total almost certainly would have been well in excess of 17 million pounds. The total catch in individual years was lowest in 1920 (322,684 pounds) and highest in 1929 (1,086,473 pounds). The average for the years 1918-1938, was 820,320 pounds.

The values (including royalties and bonuses when these were paid) of the annual yields to the Indian and white fishermen are given in the table for the years 1920 to 1938, inclusive. (The last six months of 1926 are excluded.). During these 19 years the Red Lakes fishermen received a total of $943,230. During the entire period of operation from 1917 on, the fishermen received more than one million dollars for their fish. The annual income varied from $19,190 in 1935 to $99,931 in 1929.

Beginning in 1927 statistical records were maintained continuously of the production of the individual species. The averages and percentages at the bottom of table 2, based on the 1927-1938 statistics, may be taken as descriptive of the commercial fishery in the Red Lakes for this period.

The production statistics of table 2 cannot be employed for a discussion of fluctuations in abundance since the fishery operates under a production-quota system. When the limit of 650,000 pounds, exclusive of rough fish, was reached, fishing operations other than those carried on to obtain eggs for artificial propagation were suspended for the season. The quantities of some species reported may have depended on the existence of a market demand; a particularly good example is the goldeye, the marketing of which was stimulated greatly by a growing demand for it as a smoked fish.

Relative importance of Upper and Lower Red Lakes

Although Upper and Lower Red Lakes presumably are both single-basin lakes of approximately the same regular, elliptical shape and size, Lower Red Lake has a maximum depth of about 40 feet while the maximum depth of Upper Red Lake is reported to be from 14 to 18 feet. Limnological differences between the two basins possibly may be reflected in differences in the natural abundance of fish. The relative magnitude of the commercial catches of the two lakes was related principally to number of fishermen and to fishing intensity.

A few Indian fishermen operated on both lakes, but the major part of the commercial fishing activities was centered on Lower Red Lake and very few Indians fished exclusively on Upper Red Lake. A small number of white settlers (see table 4) formerly operated gill nets on the portion of Upper Red Lake that lies outside of the reservation boundary (see fig. 1) but they were forced to sell their catch exclusively to the Red Lake Fisheries Association. Because of their violations of the fishing regulations in the past, the white settlers on Upper Red Lake were denied fishing licenses in 1938.

With a few exceptions the catches of walleyes, whitefish, yellow perch, and northern pike were recorded separately for each lake over the period 1920-1928 (table 3). All other species, termed "rough fish", constituted 10.2 percent of the total catch of Upper and 7.9 percent of the total catch of Lower Red Lake during the 9 years.

Ordinarily, except for the whitefish catches in some years, the fisheries of Upper Red Lake were only about one-tenth as important as those of the lower lake. There are indications that the fisheries of the upper lake were even less productive after 1928. Quality of the walleye from the upper lake was said to be inferior to that of lower lake fish.

Table 3.--Commercial catch of Lower and Upper Red Lakes, 1920 to 1928, inclusive.
(Percentage of the total for both lakes in parentheses)

Year[1]	All species		Walleyes		Whitefish		Yellow perch[2]		Northern pike[2]		Rough fish	
	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
1920	148,651 (46.1)	174,033 (53.9)	76,098 (40.7)	110,653 (59.3)	16,417 (41.6)	23,046 (58.4)	-	-	-	-	56,136 (58.2)	40,334 (41.8)
1921	594,463 (92.1)	50,894 (7.9)	474,330 (94.8)	25,949 (5.2)	46,573 (72.5)	17,662 (27.5)	12,108 (100.0)	- -	-	-	61,452 (89.4)	7,283 (10.6)
1922	795,870 (94.9)	42,292 (5.1)	724,230 (97.3)	20,146 (2.7)	4,444 (24.1)	14,000 (75.9)	16,963 (99.8)	31 (0.2)	-	-	50,233 (86.1)	8,115 (13.9)
1923	687,414 (96.0)	28,538 (4.0)	519,912 (99.4)	3,385 (0.6)	92,051 (80.0)	22,924 (20.0)	30,875 (100.0)	- -	24,382 (91.6)	2,225 (8.4)	20,194 (100.0)	- -
1924	893,753 (93.1)	65,861 (6.9)	700,260 (94.2)	42,832 (5.8)	69,895 (84.4)	12,870 (15.6)	19,005 (99.8)	41 (0.2)	51,299 (84.3)	9,570 (15.7)	53,294 (99.0)	548 (1.0)
1925	[3] 799,757 (85.8)	131,993 (14.2)	-	-	-	-	-	-	-	-	-	-
1926	794,003 (92.9)	61,052 (7.1)	567,077 (93.0)	42,947 (7.0)	7,074 (72.7)	2,652 (27.3)	58,462 (96.8)	1,917 (3.2)	24,481 (83.3)	4,894 (16.7)	136,909 (94.0)	8,642 (6.0)
1927	747,774 (94.4)	44,678 (5.6)	511,362 (93.4)	35,963 (6.6)	52,549 (99.9)	15 (0.1)	104,136 (95.3)	5,131 (4.7)	14,170 (90.6)	1,475 (9.4)	65,557 (96.9)	2,094 (3.1)
1928	656,181 (91.1)	64,274 (8.9)	458,812 (91.2)	44,281 (8.8)	70,874 (82.8)	14,700 (17.2)	67,812 (98.1)	1,301 (1.9)	19,939 (85.0)	3,513 (15.0)	38,744 (98.8)	479 (1.2)
Percentage of average	90.2	9.8	92.5	7.5	76.9	23.1	97.4	2.6	86.1	13.9	87.7	12.3

[1] The data for 1920-1926 are for fiscal years, beginning July 1 of the preceding year; the 1927-1928 data are for calendar years.

[2] Included with rough fish in some years.

[3] Data for individual species not available.

Table 4.-- Red Lakes production of fish in pounds by Indian and white fishermen, 1927-1938; value of catch to fishermen; and number of each kind of fishermen.

Year	Production in pounds			Value (including royalties and bonuses actually paid to Indian tribe)			Number of fishermen		
	Indians	Whites	Total[1/]	Indians	Whites	Total	Indians	Whites	Total
1927	747,774	44,678	792,452	$ 60,723	$3,195	$63,918	177	10	187
1928	656,181	64,274	720,455	66,103	4,713	70,816	184	12	196
1929	1,032,136	54,337	1,086,473	95,154	4,777	99,931	262	3/ 16	278
1930	808,995	51,123	860,118	62,184	3,683	65,867	228	3/ 58	286
1931	999,645	69,934	1,069,579	48,981	3,184	52,165	261	18	279
1932	867,165	116,381	983,546	29,463	3,631	33,094	-	-	262
1933	733,515	49,858	783,373	30,118	1,875	31,993	-	-	182
1934	819,271	47,682	866,953	2/ 30,968	1,802	32,770	3/ 192	12	204
1935	709,047	12,372	721,419	2/ 18,861	329	19,190	3/ 197	10	207
1936	755,184	2,033	757,217	2/ 20,239	54	20,293	3/ 165	3	168
1937	1,013,467	4,758	1,018,225	2/ 33,503	157	33,660	3/ 200	4	204
1938	1,061,014	0	1,061,014	2/ 36,990	0	36,990	209	0	209
Average	850,283	43,119	893,402	$44,440	$ 2,283	$46,723	205	9	222
Percentage	95.2	4.8	-	95.1	4.9	-	95.6	4.4	-

1/ The figures of total catch agree with those of table 2 except for the years 1930 and 1931.

2/ Value does not include royalties and bonuses because they were not paid although credited on the books to the Tribe. The accumulated unpaid royalties amounted to $13,708.09 at the end of December, 1938.

3/ Computed from the other two figures which were known. The number of Indians reported for 1930 appears to be too low since the computed number of whites obviously is too high. These figures were not included in the average.

Production by Indian and white fishermen

Table 4 gives the available data on the annual total production (1927-1938) by Indian and white fishermen, the value of their catches, and the number of each kind of fishermen. All of the white man's fish came from Upper Red Lake outside of the reservation. The production figures for the Indians and whites for the years 1927 and 1928 correspond exactly with those for the same years for Lower and Upper Red Lakes respectively (table 3). It is possible that the other figures of catch of table 4 also represent the yields of the two lakes, in which case the production statistics of table 4 supplement those of table 3.

During 1927-1934 Indians contributed 93 percent (not shown in table) to the total yield and white fishermen 7 percent. After 1934 the catch by whites was negligible and no licenses were issued to them in 1938. In the entire period 1927-1938 Indians contributed 95 percent and the white man 5 percent to the total catch, virtually the same relative percentages holding for the value of the product.

Seasonal distribution of the catch

Before 1930 catch statistics of the commercial fisheries of the Red Lakes were not recorded according to fishing season. In 1930, however, the newly-organized Red Lake Fisheries Association instituted a card-file system that provided for a daily record of the catch and earnings of each fisherman. From those records the seasonal catches for 1930-1938 have been compiled (table 5).

The length of the fishing seasons is a factor in the proportionate size of the total catch of the summer and fall seasons. During 1930-1933, the summer season began between July 7 and 10, but in 1934-1938 the season began about 2 weeks earlier, or between June 17 and 20. The summer season terminated between August 1 and October 7, depending upon the total number of fishermen, the abundance of fish, the number of lifts necessary to obtain the seasonal quota of 650,000 pounds (not including rough fish), and the frequency with which lifts could be made without creating unprofitable marketing conditions through oversupply. Commercial fishing during the fall season was conducted largely to obtain whitefish eggs for artificial propagation. During 1930-1938, the fall season commenced between October 4 and 20 and ended between November 3 and 14. The final date of the fall fishing was determined either by the collection of an adequate supply of whitefish eggs, or by the freezing of the lakes.

The annual summer catch of all species averaged 690,171 pounds and the annual fall catch averaged 198,768 pounds during 1930-1938. The 9-year summer average was 77.6 percent and the fall average was 22.4 percent. The summer catches of individual years comprised between 62 and 91 percent of the totals during the 9-year period. The greater summer catches were largely the result of a greater fishing intensity and a longer season. Only small-mesh gill nets (3-1/2 inches, stretched measure) are fished in the summer, whereas 5-1/2-inch mesh nets are used in the fall. These large-mesh nets do not take some of the smaller species (as, for example, perch).

The bulk of the production of every important species except whitefish and northern pike occurred in the summer season. The percentages of the average annual total production of the six principal species taken in summer were: walleyes, 80 percent; yellow perch, 91 percent; whitefish, 18 percent; northern pike, 49 percent; freshwater drum, 95 percent; and goldeyes, 97 percent. Fluctuations in summer percentages of individual years were relatively small except in the whitefish whose percentages varied from 0.4 in 1938 to 54 in 1936. Despite the fact that 80 percent of the walleyes were captured in summer, this species dominated both the summer and fall production (63 percent of the summer total and 53 percent of the fall total). Whitefish made up only 31 percent of the fall production although 82 percent of the year's take of whitefish were captured in that season. In order of production the 6 principal species in the summer were: walleyes, yellow perch, goldeyes, freshwater drum, whitefish, and northern pike. In the fall the order was: walleyes, whitefish, yellow perch, northern pike, suckers, and goldeyes.

Table 5.--Production of each species in summer and fall fishery on the Red Lakes in each year 1930-1938, species composition and percentage of average annual total of each species taken each season.

Year	Season	Production in pounds: All species	Walleyes	Yellow perch	White-fish	Northern pike	Freshwater drum	Goldeyes	Suck-ers	White carp	Bull-heads	Culls
1930	Summer	561,352	401,967	74,568	17,093	17,591	17,063	26,066	6,233	-	771	-
	Fall	185,510	51,464	2,395	100,187	24,458	538	327	5,379	758	4	-
1931	Summer	654,473	521,921	77,827	11,978	16,720	19,551	1,775	3,668	-	1,033	-
	Fall	407,364	224,294	18,282	130,603	15,644	3,190	860	4,498	-	13	9,980
1932	Summer	609,869	428,212	129,106	23,939	13,077	13,077	1,838	-	-	620	-
	Fall	373,677	223,487	24,436	108,777	15,100	1,447	52	-	-	66	312
1933	Summer	702,961	487,515	177,862	14,199	7,036	14,661	331	671	-	686	-
	Fall	80,412	54,541	5,201	14,084	6,196	219	31	90	-	50	-
1934	Summer	666,946	441,220	155,005	17,500	14,853	16,506	20,011	1,147	-	704	-
	Fall	200,007	61,612	15,133	108,727	10,897	1,213	2,335	-	-	90	-
1935	Summer	583,503	289,371	149,130	21,553	5,218	24,746	92,040	791	-	654	-
	Fall	137,916	69,835	18,712	26,273	4,004	1,191	9,730	8,115	-	56	-
1936	Summer	691,465	265,224	113,383	14,119	9,049	42,443	245,869	978	-	400	-
	Fall	65,752	42,961	3,114	12,012	4,732	290	1,514	1,126	-	3	-
1937	Summer	844,235	498,046	225,084	590	5,668	18,383	96,308	-	-	156	-
	Fall	173,990	116,174	12,477	38,284	6,407	241	407	-	-	-	-
1938	Summer	896,738	574,713	203,272	51	7,496	13,928	97,221	-	-	57	-
	Fall	164,276	107,630	27,591	14,765	12,240	1,021	1,026	-	-	3	-
Average summer production		690,171	434,243	145,026	13,447	10,745	20,040	64,606	1,499	-	565	-
Percentage composition		100.0	62.9	21.0	1.9	1.6	2.9	9.4	0.2	-	0.1	-
Average fall production		198,768	105,778	14,149	61,524	11,075	1,039	1,809	2,134	84	32	1,144
Percentage composition		100.0	53.2	7.1	31.0	5.6	0.5	0.9	1.1	0.0	0.0	0.6
Percentage taken in summer		77.6	80.4	91.1	17.9	49.2	95.1	97.3	41.3	-	94.6	-
Percentage taken in fall		22.4	19.6	8.9	82.1	50.8	4.9	2.7	58.7	100.0	5.4	100.0

Although the conclusions based on averages provide a valid comparison of summer and fall fisheries, the presence of certain exceptions to the general statements should be noted. Although whitefish were produced chiefly in the fall, the summer catches equalled or exceeded the fall production in 1933, 1935, and 1936. The fall production of whitefish was small, however, in each of these years. On the other hand, relatively high percentages of the total catch of walleyes were taken in the fall in 1931 and 1932 (30 percent and 34 percent, respectively). In no other years did the percentage of walleyes produced in the fall exceed 19. The causes for these exceptions to the general trend are unknown. Weather conditions--especially time of formation of ice--doubtless had an important effect on the fall production.

Fishermen

The numbers of fishermen who operated gill nets on Lower and Upper Red Lakes during the summer and fall seasons of 1930-1938 and the total number participating in the fishery each year (fishing in the summer only, in the fall only, or in both seasons) are recorded in table 6. Total numbers are also given for 1927-1929, in table 4. The number of summer fishermen averaged 200 for the 9-year period. There were fewer summer fishermen during 1933-1937 (also 1927 and 1928), than during 1930-1932 (probably also 1929), or in 1938. The 1933-1937 annual average of 176 summer fishermen was 25 percent less than the average of 235 for 1930-1932 and was 16 percent below 1938.

Fall fishermen for 1930 to 1938, inclusive, averaged 174 or 13 percent less than the summer fishermen during the same years. However, in 1930-1932 there was an annual average of 245 fall fishermen, and in 1933-1938 the average was 139, or 43 percent less than during the preceding 3 years.

Individuals participating in the fishery at some time during the year varied from 286 in 1930 to 168 in 1936 and averaged 223. The 1933-1938 average of 197 fishermen was 28 percent below the 1930-1932 average of 275 fishermen. The pronounced decrease in the total number of fishermen in 1933 and subsequent years was caused, at least in part, by the initiation of W. P.A. projects employing Indian labor, by the gradual elimination of the white fishermen (table 4), and by periodic free distribution of large quantities of staple foods at the Red Lake Agency.

Table 4 shows the number of Indian and white fishermen who operated during 1927-1938. The data indicate that the Indians always far outnumbered the white fishermen, comprising on the average, 96 percent of the total. An average of 205 Indians and 9 whites were engaged in commercial fishing, the number of Indians fluctuating between 165 and 262 and the number of white men varying from 0 to 18.

Fishing effort

Each Indian fisherman on the Red Lakes up to 1938 could set and lift not to exceed 5 nets, each 300 feet long, or a total of 1,500 linear feet of netting each day, as prescribed by the regulations made by the Commissioner of Indian Affairs. Nets usually were set during the late afternoon or evening and lifted the following morning so that the fishing time for each lift was one night out. Nets sometimes remained in the water for a longer time during a severe storm. Weather conditions sufficiently adverse to prevent the lifting of nets during the summer season were usually of infrequent occurrence.

The total lifts made by all fishermen during the summer and fall seasons, and during both seasons, from 1930 to 1938, appear in table 6. During the 9 years an average of 5,927 lifts of presumably 1,500 feet of small-mesh gill nets was made during the summer season, equivalent to 77 percent of the total number of lifts made during both seasons. In the fall the annual average of 1,742 lifts of presumably 1,500 feet of nets constituted 23 percent of the average number of lifts for the entire year.

The relative quantities of large-mesh and small-mesh nets used during the fall are unknown. Fishermen ordinarily employed small-mesh nets early in the fall until whitefish appear, whereupon large-mesh nets were substituted for many of the small-mesh. Some fishermen, sometimes with the approval of the manager of

the fisheries and sometimes against his wishes, used one or more small-mesh nets in their gang through the entire fall fishing season.

The total lifts during each fishing season were divided by the number of fishermen to determine the average number of lifts per fisherman (table 6).

Ordinarily the abundance of walleyes and the condition of the market controlled the length of the summer season and the number of lifts made. When walleyes were abundant and the quota was easily reached, the season was shortened and consequently the number of lifts reduced, unless market conditions necessitated interrupted fishing, when the season was prolonged but the number of lifts was not increased. Table 6 shows there was a direct relation between length of season and number of lifts and these serve, therefore, as rough indices of abundance of walleyes. On this basis we would conclude that 1930, 1931, 1932, 1937, and 1938 were good years and that 1933, 1934, 1935, and particularly 1936 were poor years. This conclusion agrees with results obtained from calculation of average catch per lift except for the years 1930 and 1933. The close correspondence of the results based on two different methods strengthens the validity of our final conclusions on relative abundance of walleyes in different years.

Although the length of the season and the number of lifts usually depended on the abundance of the fish, there is not necessarily any direct relation between these two factors and the total yield. The seasons may be relatively short and the number of lifts below average but the total catch of walleyes (table 5) may be comparatively large (1931, 1937, 1938); or the reverse may be true (1935, 1936). A direct relationship did exist, however, between length of season or number of lifts and annual yield in 1930, 1932, 1933, and 1934.

The large variation in average number of fall lifts probably was related to weather conditions and possibly also to abundance of fish. During some years the lakes froze before the peak of the whitefish spawning run occurred. If whitefish were numerous and the run occurred before the onset of freezing weather, then the desired quantity of eggs for artificial propagation could be secured with a smaller number of lifts and in a shorter time than if whitefish were scarce.

Average catch per lift

Statistics of the annual total yield of the Red Lakes fisheries cannot be employed to measure fluctuations in natural abundance of the principal species because of the controlled maximum production and limitations as to the number of lifts imposed by favorable or unfavorable condition of the wholesale market. Since all lifts presumably consisted of approximately the same quantity of gear, the average catch per lift is an approximate measure of the yield per unit of fishing effort. The total catch of each species during the summer seasons of 1930 to 1938 (table 5) was divided by the total number of summer lifts (table 6) to obtain the catch per lift (table 7). Catches and numbers of lifts during the fall seasons are unsuited for analysis in terms of catch per lift because of the mixture of small-mesh nets and large-mesh nets employed during that season.

The 9-year (1930-1938) mean of the average summer catches of all fishermen was 122 pounds per lift (table 7) distributed according to species as follows: walleye, 78; yellow perch, 26; whitefish, 2; northern pike, 2; freshwater drum, 3; goldeyes, 10; suckers, 0.2; and bullheads, 0.1.

If the average catch per lift for the 9-year interval is assumed to have an index value of 100 (or 100 percent), then the annual fluctuations in the abundance of all species and of the individual species may be estimated by expressing the catch per lift in each year as a percentage of the corresponding 9-year mean. For example, the catch per lift of all species combined in 1930 was $100 \times \frac{85.2}{122}$ or 70 percent of the 1930-1938 average; similarly the "abundance percentage" for walleyes in the same year was $100 \times \frac{61.6}{78.4} = 78$. Table 8 contains no computations of abundance percentages for goldeyes, suckers, and bullheads. Data for the last two species were scanty and fluctuations in the catch per lift of goldeyes are believed to be unreliable as measures

Table 6.--Fishermen in the summer and fall fisheries, length of summer fishing season, average lifts per fisherman in summer and fall fisheries, and lifts in summer, fall, and entire year on the Red Lakes, 1930-1938.

Year	Number of fishermen			Number of fishing days in summer	Average number of lifts per fisherman		Total number of lifts		
	Summer	Fall	Total		Summer	Fall	Summer	Fall	Both seasons
1930	263	241	286	29	25.0	7.9	6,586	1,901	8,487
1931	240	255	277	45	24.1	11.0	5,794	2,815	8,609
1932	203	240	262	46	19.0	16.3	3,860	3,920	7,780
1933	171	110	182	61	31.7	4.2	5,417	459	5,876
1934	189	136	204	70	35.3	14.0	6,672	1,905	8,577
1935	187	153	207	87	37.9	9.5	7,087	1,460	8,547
1936	156	116	168	104	49.6	4.9	7,842	572	8,414
1937	177	159	204	40	29.2	8.8	5,172	1,393	6,565
1938	209	158	216	31	23.5	7.9	4,910	1,253	6,163
Average	200	174	223	57	29.6	10.0	5,927	1,742	7,669
Percentage	89.7	78.0	100.0	-	-	-	77.3	22.7	100.0

Table 7.--Average production in pounds per individual lift of approximately 1,500 feet of small-mesh gill nets on the Red Lakes during summer fishing seasons of 1930-1938.

Year	Average catch in pounds per lift								
	All species	Walleyes	Yellow perch	White-fish	Northern pike	Freshwater drum	Gold-eyes	Suckers	Bull-heads
1930	85.2	61.0	11.3	2.6	2.7	2.8	4.0	1.0	0.1
1931	113.0	90.1	13.4	2.1	2.9	3.4	0.3	0.6	0.2
1932	158.0	110.9	33.4	6.2	3.4	3.4	0.5	0.0	0.2
1933	129.8	90.0	32.8	2.6	1.3	2.7	0.1	0.1	0.1
1934	100.0	66.1	23.2	2.6	2.2	2.5	3.0	0.2	0.1
1935	82.3	40.8	21.0	3.0	0.7	3.5	13.0	0.1	0.1
1936	88.2	33.8	14.5	1.8	1.2	5.4	31.4	0.1	0.1
1937	163.2	96.3	43.5	0.1	1.1	3.6	18.6	0.0	1/
1938	182.6	117.0	41.4	1/	1.5	2.8	19.8	0.0	1/
Annual average 2/	122.5	78.4	26.1	2.3	1.9	3.3	10.1	0.2	0.1

1/ Less than 0.05 pound per lift.

2/ Unweighted mean of the averages for the several years.

Table 8.--Percentage relations of average catches per lift for 1930-1938 to the average catch per lift for the 9-year period in the Red Lakes fisheries during the summer fishing season (based on the data of table 7).

Year	All species	Walleyes	Yellow perch	Whitefish	Northern pike	Freshwater drum
1930	70	78	43	111	143	78
1931	92	115	51	90	153	102
1932	129	141	128	266	180	102
1933	106	115	126	111	69	81
1934	82	84	89	111	117	75
1935	67	52	81	129	37	106
1936	72	43	56	78	64	163
1937	133	123	167	4	58	109
1938	149	149	159	0	79	84

of abundance since quantities that could not be sold were not reported. Data for walleyes and perch are more reliable than those for the other species.

The catch per lift of all species combined was only 70 percent of average in 1930. The abundance of fish improved in 1931, and was 29 percent above the 9-year average in 1932. Abundance declined during the next 3 years, reaching the 9-year minimum of 67 percent in 1935. A slight increase in abundance in 1936 was followed by a sharp upturn to 133 percent in 1937 and further, though less pronounced, improvement in 1938 to the 9-year maximum (149 percent). The catch per lift of all fish combined in both 1937 and 1938 exceeded that in any year of the period 1930-1936.

As might be expected, the annual fluctuations in the abundance percentages of walleyes resembled the fluctuations for all species combined. The directions of change were the same in all years except 1936 when the abundance of all fish combined improved (from 67 in 1935 to 72 in 1936) while that of walleyes declined (from 52 in 1935 to 43 in 1936). Measured in terms of the average catch per lift the abundance of walleyes was greatest in 1938 (149 percent of average) and was above average in 1931-1933 and in 1937. Walleyes were least abundant in 1936 (43 percent of average) and were below "normal" in 1930 and 1934-1936. The rapid changes in the abundance of walleyes in certain years are especially striking. As an outstanding example the 1937 abundance was 2.9 times that of 1936, and the years of greatest and least abundance (1938 and 1936) were separated by a single intervening year.

Fluctuations in catch per left of yellow perch resembled those of all fish combined and of the walleye. Examination of the data with respect to the occurrence of "above-normal" and "below-normal" years reveals complete agreement between the perch and all species combined and agreement between the perch and the walleye in every year except 1931 (perch below average and walleye above average). The directions of change in the abundance of perch and walleyes were the same in every year but 1938 (a slight decrease in the abundance of perch and an increase in the abundance of walleyes). It was concluded that trends in the fluctuations in abundance of yellow perch and walleyes were closely similar in the period 1930-1938, although the actual values of the abundance percentages differed considerably in some years. There are no data upon which to explain this obvious correlation. Perch were most abundant in 1937 (167 percent) and were nearly as abundant in 1938 (159 percent). Their abundance was above average also in 1932 and 1933. Perch were least abundant in 1930 (43 percent) and were below average in 1931 and 1934-1936. The most pronounced change in abundance occurred from 1936 to 1937. (1937 abundance percentage was three times that of 1936).

The very poor catches of walleyes in 1935 and 1936 were attributed to abnormally low water levels. The vegetation along the shore, favorable spawning and feeding grounds of minnows, was exposed. It was thought that a subsequent reduction in forage fishes caused a loss in weight of the predator walleyes so that many of marketable length could no longer be caught in the 3-3/4-inch meshes, thereby decreasing the catch in pounds per unit of net. Figures were brought forward to show that in 1934 the average weight of the walleye in the commercial catch was 1.2 pounds but in 1936 it was only 0.9 pound. In 1938 the average weight was again 1.2 pounds. The water level was said to have been from 4-1/2 to 5 feet higher in 1938 than in 1936.

Because 3-3/4-inch mesh did not take walleyes of marketable size, the manager of the fisheries in 1936 authorized mesh of 3-1/2-inches. The effect of this reduction in size of mesh apparently is reflected in the increased catch per unit of effort in 1937. The still further rise in catch in 1938 is explained, in part at least, by the increased average weight of the fish. The walleyes were in better condition in 1938 than in several preceding years.

It is not apparent why the catch of perch should drop so low in 1936, but the reduction in mesh size is responsible for part if not all of the rise in catch in 1937 and 1938.

Abundance percentages of whitefish cannot be considered dependable. Summer is a poor season for capture of whitefish, and annual fluctuations in catch per lift may depend more on limnological conditions that determine whether whitefish are present

on the grounds fished for other species than on the actual abundance of fish. Neither would abundance percentages of the whitefish taken in the fall be reliable, not only because of the unknown number of small-mesh nets fished with the whitefish nets, but also because of the variations in weather conditions which in some years, for example 1938, would delay the spawning season to such an extent that it would not reach its climax before commercial fishing operations were suspended for the year.

Catch per lift of northern pike was well above average in 1930, improved in 1931, and reached a maximum in 1932. A sharp decline in 1933 was followed by a less sharp improvement in 1934. The abundance of northern pike appears to have been consistently below average throughout the period, 1935-1938.

Catches of freshwater drum were above average in 1931, 1932, and 1935-1937 and below average in 1930, 1933, 1934, and 1938. The best catches were made in 1936 and the poorest in 1934.

The preceding discussion was based on the data of all fishermen in each summer's fishing. In view of the considerable annual fluctuations in the number of fishermen (table 6), the possibility was considered that some of the observed variations in the catch per lift may have originated in variations from year to year in the skill and ability of the fishermen engaged. To test this possibility an analysis was made of the annual fluctuations in the catch per lift of 19 selected fishermen (the best fishermen as selected by the manager) who fished each year throughout the period 1930-1938. Although the average catch per lift of all species made by the 19 fishermen was 1.5 times the average catch per lift obtained by all fishermen during the years 1930-1938, the conclusions, with respect to relative abundance, that would have been drawn from the data of these selected fishermen were practically identical with those based on the data of all fishermen. The description of fluctuations in abundance from annual variations in the catch per lift of all fishermen may be considered valid.

THE WALLEYES OF LOWER RED LAKE

The walleye, as demonstrated during the preceding discussion of the statistics of the commercial fisheries of the Red Lakes, was by far the most important species produced. During 1927-1938, the walleye averaged 62.3 percent of the annual catch.

Scale samples, accompanied by records of standard, fork, and total lengths, weight, sex, and stage of maturity, were collected from 127 individuals which represented the unselected catch obtained by 3 fishermen on August 24, 1938, in 18 nets. Similar data were obtained on August 25 from 185 fish selected to secure a good representation of fish of all sizes and ages. Length measurements only were obtained from 470 walleyes, which, together with the 185 from which scale samples were taken, constituted the total number taken by 6 fishermen from 34 nets lifted on August 25.

The scales, cleaned and mounted on slides in a glycerine-gelatine medium, were studied on a microprojection machine. Measurements of the projected images of the scales from the focus (center) to each annulus (yearring) and to the edge of the scale were used to calculate lengths of the fish at the end of each year of life. Computations were made by the direct-proportion method. Ages are designated by roman numerals which denote the number of annuli (year rings) on the scales or completed years of life of the fish. Since the collections were made during the growing season each fish was actually a fraction of a year older than the age indicates.

Length-frequency distributions

The length-frequency distributions of the various age groups of walleyes (table 9) have been based on a combination of 127 fish of an unassorted sample and 185 individuals selected to obtain a better representation of fish over certain length intervals. Comparisons of the frequency distributions of the age groups in table 9 with the distributions based on the unassorted sample of 127 fish (not shown), revealed that the inclusion of the selected individuals did not affect the data significantly. Inclusion of the selected fish did, however, affect the age composition of the samples as may be seen by the comparison of the percentage age compositions of the unassorted sample (bottom of table) and the sample containing both unassorted and selected fish. In the unassorted sample age-groups IV and V made up 81.9 percent of the total; in the combined samples, 64.3 percent. Age-group IV dominated both samples. At the extreme right of the table is the distribution of fish in the

Table 9.--Frequency distribution according to age groups and centimeter intervals of standard length of combined unassorted and selected samples of the catch of walleyes in commercial 3-1/2-inch gill nets in Lower Red Lake on August 24 and 25, 1938.

Standard length (millimeters)	Equivalent fork length (inches)	Equivalent total length (inches)	Age group								Distribution in commercial catch	
			0	I	II	III	IV	V	VI	0-VI	Number	Percentage
80-89	3.6-4.0	3.8-4.2	1	-	-	-	-	-	-	1	-	-
90-99	4.0-4.4	4.3-4.7	-	-	-	-	-	-	-	-	-	-
100-109	4.5-4.9	4.8-5.2	-	-	-	-	-	-	-	-	-	-
110-119	4.9-5.3	5.2-5.6	1	-	-	-	-	-	-	1	-	-
120-129	5.4-5.7	5.7-6.1	-	-	-	-	-	-	-	-	-	-
130-139	5.8-6.2	6.2-6.6	-	-	-	-	-	-	-	-	-	-
140-149	6.2-6.6	6.6-7.1	-	-	-	-	-	-	-	-	-	-
150-159	6.7-7.1	7.1-7.6	-	-	-	-	-	-	-	-	-	-
160-169	7.1-7.5	7.6-8.0	-	1	-	-	-	-	-	1	2	0.3
170-179	7.6-8.0	8.1-8.5	-	5	-	-	-	-	-	5	7	0.9
180-189	8.0-8.4	8.6-9.0	-	5	-	-	-	-	-	5	4	0.5
190-199	8.5-8.9	9.0-9.4	-	4	1	-	-	-	-	5	5	0.6
200-209	8.9-9.3	9.5-9.9	-	1	-	-	-	-	-	1	-	-
210-219	9.4-9.8	10.0-10.4	-	-	6	-	-	-	-	6	8	1.0
220-229	9.8-10.2	10.4-10.9	-	-	13	-	-	-	-	13	14	1.8
230-239	10.2-10.6	10.9-11.4	-	-	7	-	-	-	-	7	14	1.8
240-249	10.7-11.1	11.4-11.8	-	-	8	-	-	-	-	8	7	0.9
250-259	11.2-11.6	11.9-12.3	-	-	6	1	-	-	-	7	10	1.3
260-269	11.6-12.0	12.4-12.8	-	-	2	6	-	-	-	8	6	0.8
270-279	12.0-12.4	12.8-13.2	-	-	1	14	4	-	-	19	11	1.4
280-289	12.5-12.9	13.3-13.7	-	-	-	10	9	2	-	21	20	2.5
290-299	12.9-13.3	13.8-14.2	-	-	-	11	19	-	-	30	40	5.1
300-309	13.4-13.8	14.2-14.7	-	-	-	7	15	8	-	30	98	12.5
310-319	13.8-14.2	14.7-15.2	-	-	-	1	18	11	-	30	139	17.8
320-329	14.3-14.7	15.2-15.6	-	-	-	-	19	16	-	35	158	20.2
330-339	14.7-15.1	15.7-16.1	-	-	-	-	14	17	-	31	128	16.4
340-349	15.2-15.6	16.2-16.6	-	-	-	-	4	17	2	23	69	8.8
350-359	15.6-16.0	16.6-17.0	-	-	-	-	4	14	1	19	31	4.0
360-369	16.0-16.4	17.1-17.5	-	-	-	-	1	2	2	5	11	1.4
Combined unselected and selected samples		(Total	2	16	44	44	113	87	5	311	Total number in commercial sample=782	
		(Percentage	0.6	5.1	14.2	14.2	36.3	28.0	1.6	100.0		
Individuals under 14 inches, fork length		(Number	2	16	44	43	52	18	0	-	Number below 14 inches, fork length, in above catch=295	
		(Percentage	100.0	100.0	100.0	97.7	46.0	20.7	0.0	-		
Unselected sample only		(Number	-	2		9	58	46	2	127	Percentage below 14 inches, fork length=37.7	
		(Percentage	-	1.6	7.8	7.1	45.7	36.2	1.6	100.0		

commercial catch as determined from a series of unassorted samples.

With the exception of the 0-group the frequency distributions of the successive age groups overlap; this overlap increased with increase in size and age. Every length interval beyond 240-249 millimeters, standard length, was represented by fish of two or three age groups.

All walleyes of age-groups 0, I, and II, and all but one of the III group were below 14 inches fork length. Forty-six percent of the IV-group fish, and 21 percent of the V-group were shorter than 14 inches. All individuals of the age-group VI were well above 14 inches. In the unassorted samples (782 fish) from the commercial catch, 38 percent were below and 62 percent above 14 inches.

The range of length over which the gill nets took walleyes in abundance was delimited sharply. Seventy-six percent of the total catch fell within the length range, 13.4-15.6 inches, fork length (14.2-16.6 inches, total length; 0.9-1.4 pounds). Nearly all of these fish belonged to age-groups IV and V. The irregular and discontinuous distribution of the smaller fish suggests that many of them were "accidental" captures, that is, were not gilled in the customary manner but were entangled in the webbing of the nets by their mouth parts, teeth, or fins. No individual exceeded 17.5 inches in total length. An attempt to obtain larger specimens failed. One informant asserted that in the period 1927-1932, the walleye averaged much larger; fish of 4 or 5 pounds were common in the earlier period, when a 4-inch mesh gill net could take them in the deeper water.

Rate of growth

Lengths, weights, and coefficients of condition of each age group of the Lower Red Lake walleye are shown in table 10 for each sex, and calculated lengths according to age group or year of life are presented in table 11 and fig. 2. Inspection of average lengths at time of capture shows no differences or only slight differences between males and females of age-groups I, II, and III, but females of age-groups IV and V averaged distinctly longer than the males. (The scanty data of age-group VI do not permit a comparison of the sexes.) The average weights show a similar sex difference in age-groups IV and V, where females averaged slightly heavier than the males.

The calculated standard lengths at the end of the first year of life (table 11) were higher in age-group I than in any of the older age groups. The small fish were taken in large-mesh gill nets and probably were the larger and more rapidly growing members of the age group. The same explanation applies to the larger of the two 0-group fish that were 89 and 116 millimeters, standard length, at the time of capture. The calculated lengths of age-groups II-VI doubtless were affected less by gear selection and may be taken as descriptive of the growth history of the population. The calculated lengths shown at the bottom of table 11 are based on data of age-groups II-VI. Age-group I was excluded from these compilations since it was probably unrepresentative. The grand average calculated lengths represent the successive summations of the grand average annual increments of growth in length. This procedure provides a smoother growth curve and one more in conformity with the actual data on the growth in different years of life.

In all the well represented age groups except the II group, the calculated lengths of the females tended to be greater than those of males, especially during the later years of life. This superiority in the growth of the females may be seen also in the grand average calculated lengths. (See also fig. 2.) The advantage of the females was insignificant (only 1 millimeter) at the end of the first year of life but increased continuously with increase in age to a maximum advantage of 19 millimeters at the end of the sixth year. The most rapid growth of both sexes occurred in the first year of life. Growth increments decreased in each of the later years but the decline was most rapid in the third and fourth years.

Comparison of the growth in Lower Red Lake and in other waters

Calculated lengths and annual increments of length for the various years of life of walleyes

Table 10.--Number of specimens, lengths, weight, increment of weight, and coefficient of condition, K, of walleyes from Lower Red Lake.

Age group	Sex[1/]	Number of fish	Standard length (millimeters)	Fork length (inches)	Total length (inches)	Weight (pounds)	Increment of weight (pounds)	Weight (grams)	K
0	F	1	116	5.2	5.5	0.03	-	14	0.90
	M,F[2/]	2	102	4.5	4.9	0.02	-	11	0.94
I	M	8	184	8.2	8.8	0.20	-	90	1.34
	F	8	184	8.2	8.7	0.20	0.17	93	1.49
	M, F	16	184	8.2	8.8	0.20	0.18	91	1.41
II	M	20	237	10.6	11.2	0.44	0.24	200	1.48
	F	24	232	10.3	11.0	0.41	0.21	184	1.46
	M, F	44	234	10.4	11.1	0.42	0.22	192	1.47
III	M	24	282	12.6	13.3	0.74	0.30	336	1.50
	F	20	284	12.7	13.5	0.74	0.33	336	1.45
	M, F	44	283	12.6	13.4	0.74	0.32	336	1.48
IV	M	58	305	13.6	14.5	1.00	0.26	433	1.52
	F	55	323	14.4	15.1	1.07	0.33	504	1.48
	M, F	113	313	14.0	14.8	1.03	0.29	468	1.50
V	M	17	315	14.0	15.0	1.05	0.05	478	1.52
	F	70	336	15.0	15.9	1.23	0.16	563	1.47
	M, F	87	332	14.8	15.7	1.20	0.17	546	1.48
VI	M	1	367	16.4	17.3	1.61	0.56	730	1.48
	F	4	352	15.7	16.7	1.44	0.21	655	1.50
	M, F	5	355	15.8	16.8	1.48	0.28	670	1.49

1/ M = male; F = female.

2/ Includes one individual of undetermined sex.

Table 11.--Length (in millimeters) of each age group of walleyes at capture, calculated growth histories of the age groups, and grand average calculated lengths and increments of length for all age groups combined.

Age group	Sex[1]	Number of fish	Actual standard length	Calculated length at end of year of life					
				1	2	3	4	5	6
0	F	1	116	-	-	-	-	-	-
	M,F[2]	2	102	-	-	-	-	-	-
I	M	8	184	131	-	-	-	-	-
	F	8	184	124	-	-	-	-	-
	M,F	16	184	128	-	-	-	-	-
II	M	20	237	90	197	-	-	-	-
	F	24	232	86	193	-	-	-	-
	M, F	44	234	88	195	-	-	-	-
III	M	24	282	88	182	244	-	-	-
	F	20	284	94	187	250	-	-	-
	M, F	44	283	91	184	247	-	-	-
IV	M	58	305	95	176	236	278	-	-
	F	55	322	95	180	244	289	-	-
	M, F	113	313	95	178	240	283	-	-
V	M	17	315	88	165	223	264	292	-
	F	70	336	94	178	238	279	314	-
	M, F	87	332	93	175	235	276	309	-
VI	M	1	367	104	180	244	291	323	347
	F	4	352	94	179	225	274	306	336
	M, F	5	355	96	179	229	278	310	338
Grand average calculated length[3]	M			92 (120)	179 (120)	239 (100)	281 (76)	309 (18)	333 (1)
	F			93 (173)	182 (173)	244 (149)	287 (129)	322 (74)	352 (4)
	M, F			93 (293)	181 (293)	242 (249)	285 (205)	318 (92)	346 (5)
Average annual increment of length	M			92	87	60	42	28	24
	F			93	89	62	43	35	30
	M, F			93	88	61	43	33	28

1/ M = male; F = female.

2/ Includes one individual of undetermined sex.

3/ Number of individuals in parentheses; age-group I not included in the computation of averages.

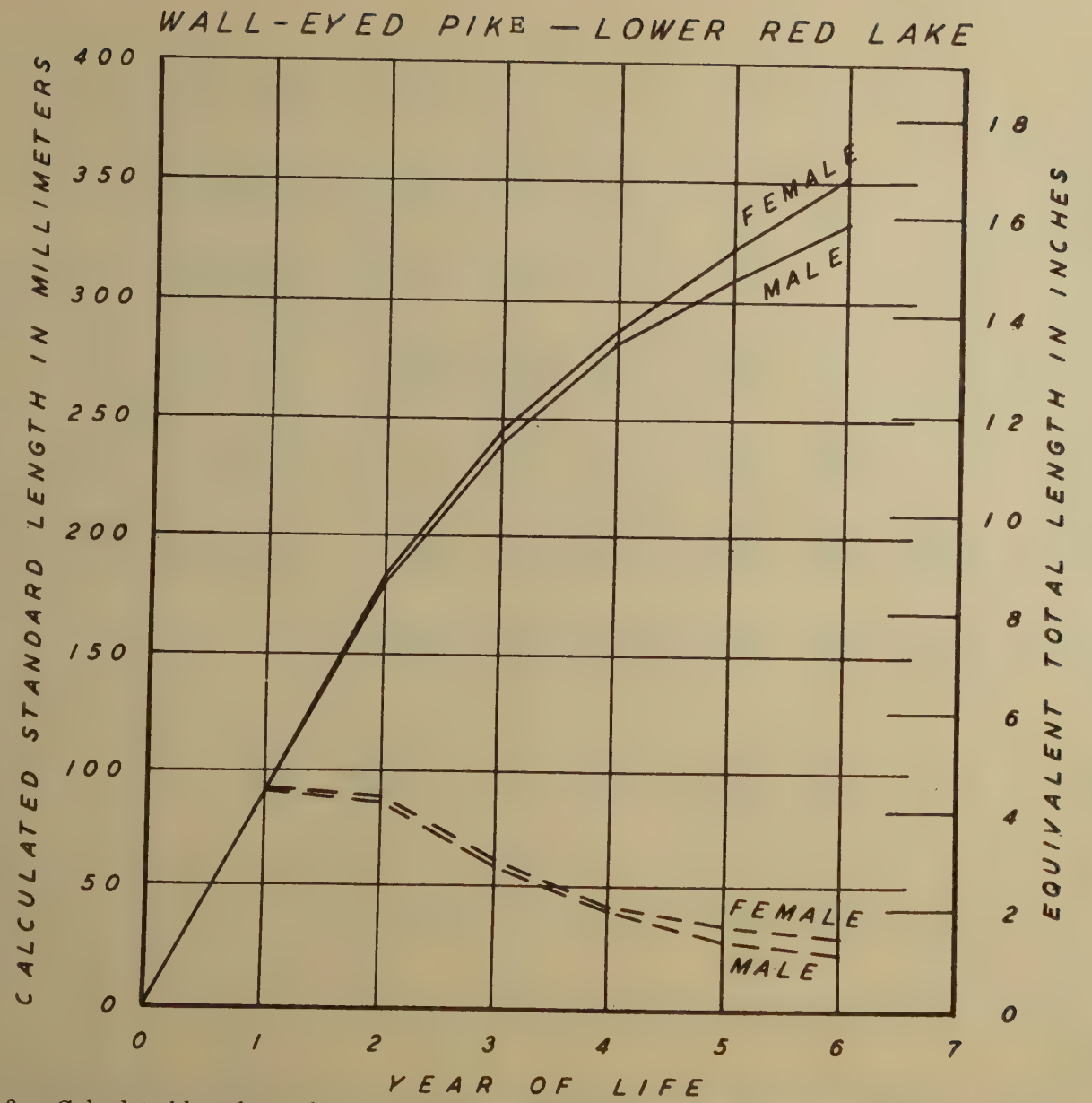

Figure 2.--Calculated lengths at the end of each year of life (continuous lines) and annual increments of length (broken lines) of male and female walleyes from Lower Red Lake (data from table 11).

from Lower Red Lake, Lake of the Woods and Lake Erie (Deason, ms.) are compared in table 12. (Also see fig. 3.) Fish from Lower Red Lake and Lake of the Woods grew more rapidly (93 and 94 millimeters) during the first year than in Lake Erie. During the second year, Lake Erie fish grew more rapidly than during their first year in contrast to the Red Lake and Lake of the Woods fish, which grew more slowly during their second year than during the first. Beyond the second year the growth increments of Lake Erie fish were the largest in every year but one (the fourth) and the increments of the Red Lake fish were the smallest in every year except the sixth. The grand average calculated lengths of the Lake Erie walleyes were the largest and those of the Red Lake fish the smallest in all years beyond the second.

Hart (1928) studied the growth of walleyes from Lakes Nipigon and Abitibi, Ontario by means of age determinations, but did not calculate growth from scale measurements. The average fork and converted total lengths and weights of the Nipigon and Abitibi fish are compared in table 13 with similar data from Lower Red Lake, Lake of the Woods, and Lake Erie. Lower Red Lake fish averaged shorter and lighter in most age groups than Lake Erie and Lake of the Woods individuals. However, the walleyes from Lakes Nipigon and Abitibi were much slower growing than those from Lower Red Lake during the period covered by the 1938 samples.

A comparison of the growth of the Red Lake walleye with average growth of the species in Minnesota as determined by Eddy and Carlander (1939) indicated that Red Lake fish grew more slowly than the average except in the first year of life during the years covered by data collected in 1938.

Length-weight relation and coefficient of condition

Examination of the average values of the coefficient of condition for the age groups (table 10) as well as of the length-weight data (not presented) revealed no large differences between sexes although males tended to be in slightly better condition than the females of corresponding age. Accordingly, data for the sexes were combined in the preparation of table 14. Each entry is the average for all fish within a 5-millimeter interval of standard length. These data form the basis of the length-weight curve in figure 4 which has been so constructed that conversions of weight in ounces to weight in grams and standard lengths in millimeters to fork or total lengths in inches may be accomplished readily.

The coefficient of condition, $\underline{K}$ [2/] is a measure of the relative heaviness of fish or groups of fish. Large values of $\underline{K}$ indicate a heavy, robust fish, while small values of $\underline{K}$ indicate a slender, less stockily built individual. The values of $\underline{K}$ of the Lower Red Lake walleye exhibited no important or consistent changes with increase in length beyond 172 millimeters, standard length. The values do, however, tend to be slightly higher in the older fish (age-groups IV-VI) than in the younger (age-groups 0-III). (See table 10.) Very small and young individuals apparently are quite slender as indicated by the low $\underline{K}$ of the two smallest fish (standard lengths of 89 and 116 millimeters).

Maturity and sex ratio

The size at maturity will vary somewhat in different populations. In this study a fish is considered to be mature if the state of its organs indicated that it would spawn the next spring, regardless of whether it had spawned before.

Available data on maturity of Lower Red Lake walleyes are presented in table 15, which shows the number and percentage of mature and immature individuals in each age group, and in table 16, which shows the number of mature and immature fish and the percentage of maturity according to length with all age groups combined. The youngest mature individuals occurred in age-group II (in third summer) of the males and in age-group III of the females. In each sex, the youngest group with a majority of mature individuals was the IV group (93 percent of the males and 69 percent of the females mature)

[2/] $\underline{K} = \frac{\underline{W} \times 10^{5}}{\underline{L}^{3}}$ [3/]; $\underline{W}$ = weight in grams, $\underline{L}$ = standard length in mm.

Table 12.--Comparison of the calculated growth of walleyes from Lower Red Lake, Lake Erie, and Lake of the Woods (number of specimens in parentheses).

Year of life	Calculated standard lengths (millimeters)			Annual increments (millimeters)		
	Lower Red Lake	Lake of the Woods	Lake Erie	Lower Red Lake	Lake of the Woods	Lake Erie
1	93 (293)	94 (269)	87 (1,993)	93	94	87
2	181 (293)	176 (269)	183 (1,993)	88	82	96
3	242 (249)	251 (247)	264 (1,098)	61	75	80
4	285 (205)	308 (125)	318 (572)	43	57	53
5	318 (92)	349 (84)	364 (181)	33	41	45
6	346 (5)	375 (25)	400 (97)	28	26	35
7	-	398 (7)	431 (13)	-	23	31
8	-	-	458 (2)	-	-	25
9	-	-	493 (2)	-	-	35

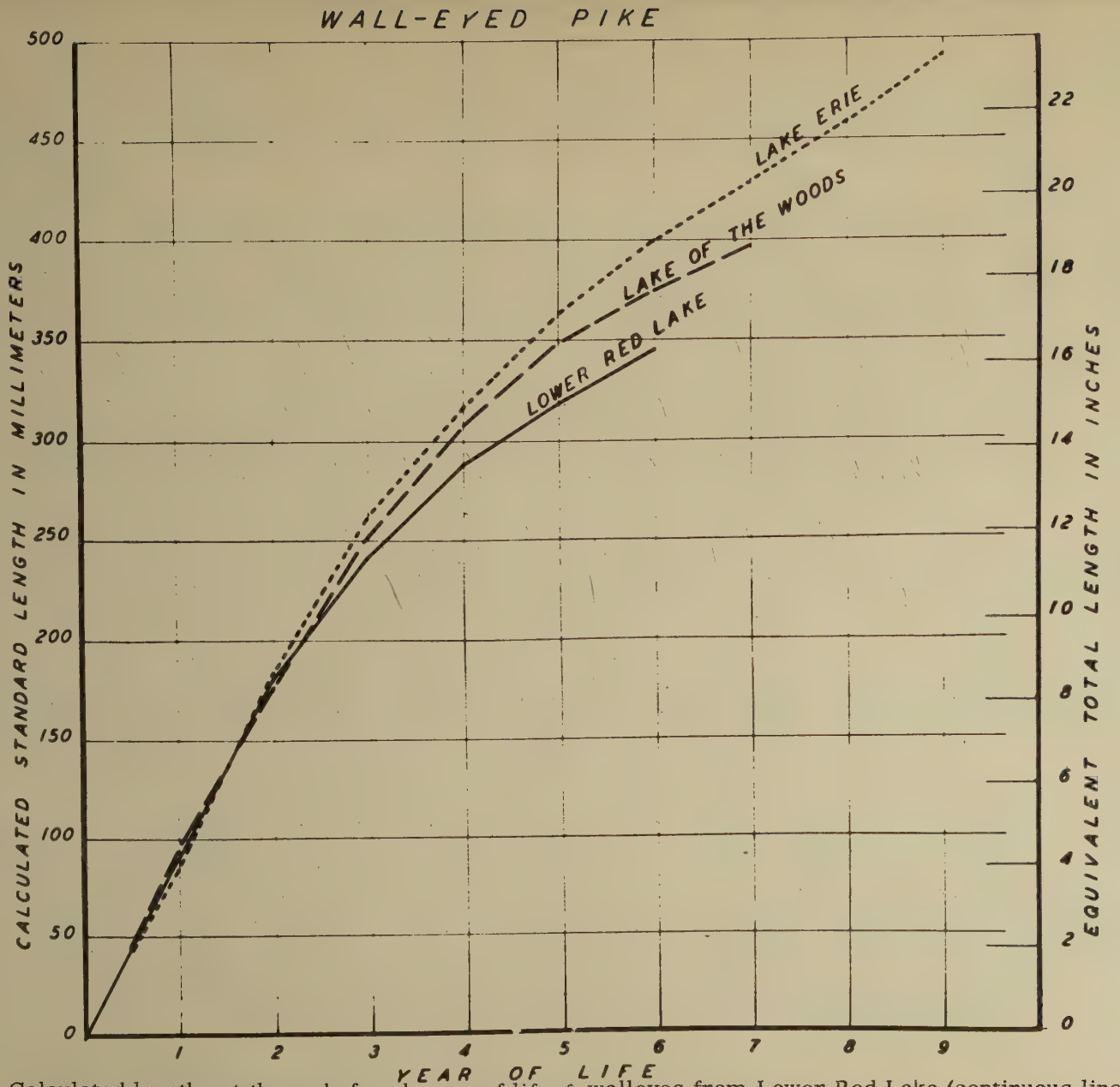

Figure 3.--Calculated lengths at the end of each year of life of walleyes from Lower Red Lake (continuous line), Lake of the Woods (long dashes), and Lake Erie (short dashes) (data from table 12).

Table 13.--Comparison of fork and total lengths in inches and weight in pounds of walleyes according to age groups, from various localities (number of specimens in parentheses).

Age group	Fork length					Total length					Weight				
	Lower Red Lake	Lake of the Woods	Lake Erie	Lake Nipigon 1/	Lake Abitibi 1/	Lower Red Lake	Lake of the Woods	Lake Erie	Lake Nipigon	Lake Abitibi	Lower Red Lake	Lake of the Woods	Lake Erie	Lake Nipigon	Lake Abitibi
0	4.5 (2)	-	-	-	-	4.9	-	-	-	-	0.02	-	-	-	-
I	8.2 (16)	-	9.1 (669)	5.5 (4)	-	8.8	-	9.7	5.8	-	0.20	-	0.28	0.09	-
II	10.4 (44)	11.7 (22)	11.3 (895)	7.5 (15)	7.8 (1)	11.1	12.4	12.0	8.0	8.3	0.42	0.58	0.50	0.16	0.12
III	12.6 (44)	13.3 (122)	12.2 (594)	9.5 (2)	-	13.4	14.0	12.9	10.1	-	0.74	0.85	0.64	0.25	-
IV	14.0 (113)	14.4 (41)	13.8 (391)	12.2 (8)	11.0 (2)	14.8	15.1	14.6	13.0	11.7	1.03	1.11	0.98	0.59	0.47
V	14.8 (87)	16.0 (59)	15.7 (84)	13.8 (9)	11.5 (1)	15.7	16.9	16.7	14.7	12.2	1.20	1.55	1.44	0.91	0.50
VI	15.8 (5)	17.0 (18)	17.5 (84)	13.8 (9)	12.5 (1)	16.8	17.9	18.6	14.7	13.3	1.48	1.85	2.11	0.97	0.69
VII	-	18.4 (7)	19.9 (11)	15.0 (2)	13.5 (4)	-	19.4	21.1	16.0	14.4	-	2.35	3.14	1.19	0.88
VIII	-	-	-	18.0 (4)	17.2 (7)	-	-	-	19.2	18.3	-	-	-	1.94	1.69
IX	-	-	25.5 (2)	18.8 (3)	17.5 (10)	-	-	27.1	20.0	18.6	-	-	7.17	2.09	1.81
X	-	-	-	20.2 (10)	18.0 (3)	-	-	-	21.5	19.2	-	-	-	3.12	2.00
XI	-	-	-	20.8 (10)	17.0 (2)	-	-	-	22.2	18.1	-	-	-	3.12	1.44
XII	-	-	-	21.5 (5)	-	-	-	-	22.9	-	-	-	-	4.31	-
XIII	-	-	-	-	22.5 (1)	-	-	-	-	24.0	-	-	-	-	4.38
XIV	-	-	-	23.2 (1)	21.0 (1)	-	-	-	24.7	22.4	-	-	-	4.50	3.43
XV	-	-	-	25.0 (2)	-	-	-	-	26.6	-	-	-	-	8.50	-

1/ Data from Hart (1928)

Table 14.--Length-weight relationship and coefficient of condition of the Lower Red Lake walleye.

Standard length (millimeters)	Weight (grams)	Fork length (inches)	Total length (inches)	Weight (ounces)	Weight (pounds)	K	Number of fish
89	7	4.0	4.2	0.25	0.02	0.99	1
116	14	5.2	5.5	0.50	0.03	0.90	1
163	57	7.3	7.7	2.00	0.12	1.32	1
172	75	7.7	8.2	2.63	0.16	1.49	2
178	83	7.9	8.4	2.92	0.18	1.47	3
183	94	8.2	8.7	3.31	0.21	1.53	4
189	92	8.4	9.0	3.25	0.20	1.36	1
192	99	8.6	9.1	3.50	0.22	1.40	3
198	113	8.8	9.4	4.00	0.25	1.44	2
206	120	9.2	9.8	4.25	0.26	1.37	1
212	151	9.4	10.1	5.33	0.33	1.58	3
218	160	9.7	10.4	5.63	0.35	1.56	3
223	159	9.9	10.6	5.61	0.35	1.33	8
227	174	10.1	10.8	6.15	0.38	1.48	5
232	190	10.3	11.0	6.70	0.42	1.53	5
238	195	10.6	11.3	6.88	0.43	1.45	2
242	210	10.8	11.5	7.42	0.46	1.47	6
246	227	11.0	11.7	8.00	0.50	1.52	2
252	223	11.2	12.0	7.88	0.49	1.39	6
256	248	11.4	12.2	8.75	0.55	1.43	1
263	291	11.7	12.5	10.25	0.64	1.60	1
266	291	11.9	12.6	10.25	0.64	1.54	7
272	304	12.1	12.9	10.73	0.67	1.51	10
277	308	12.4	13.2	10.86	0.68	1.45	9
282	334	12.6	13.4	11.77	0.74	1.50	13
288	358	12.8	13.7	12.63	0.79	1.51	8
292	369	13.0	13.9	13.00	0.81	1.48	19
297	388	13.2	14.1	13.70	0.86	1.48	11
302	407	13.5	14.3	14.34	0.90	1.48	17
307	451	13.7	14.6	15.91	0.99	1.55	13
312	460	13.9	14.8	16.23	1.01	1.51	13
317	485	14.1	15.0	17.09	1.07	1.52	17
322	498	14.4	15.3	17.58	1.10	1.49	22
327	507	14.6	15.5	17.88	1.12	1.45	13
332	535	14.8	15.8	18.88	1.18	1.46	14
336	571	15.0	16.0	20.13	1.26	1.50	17
343	600	15.3	16.3	21.16	1.32	1.49	9
347	610	15.5	16.5	21.52	1.34	1.46	14
351	638	15.6	16.7	22.52	1.41	1.47	11
358	658	16.0	17.0	23.22	1.45	1.44	8
360	638	16.1	17.1	22.50	1.41	1.36	2
367	732	16.4	17.4	25.83	1.61	1.48	3
Average and total						1.48	311

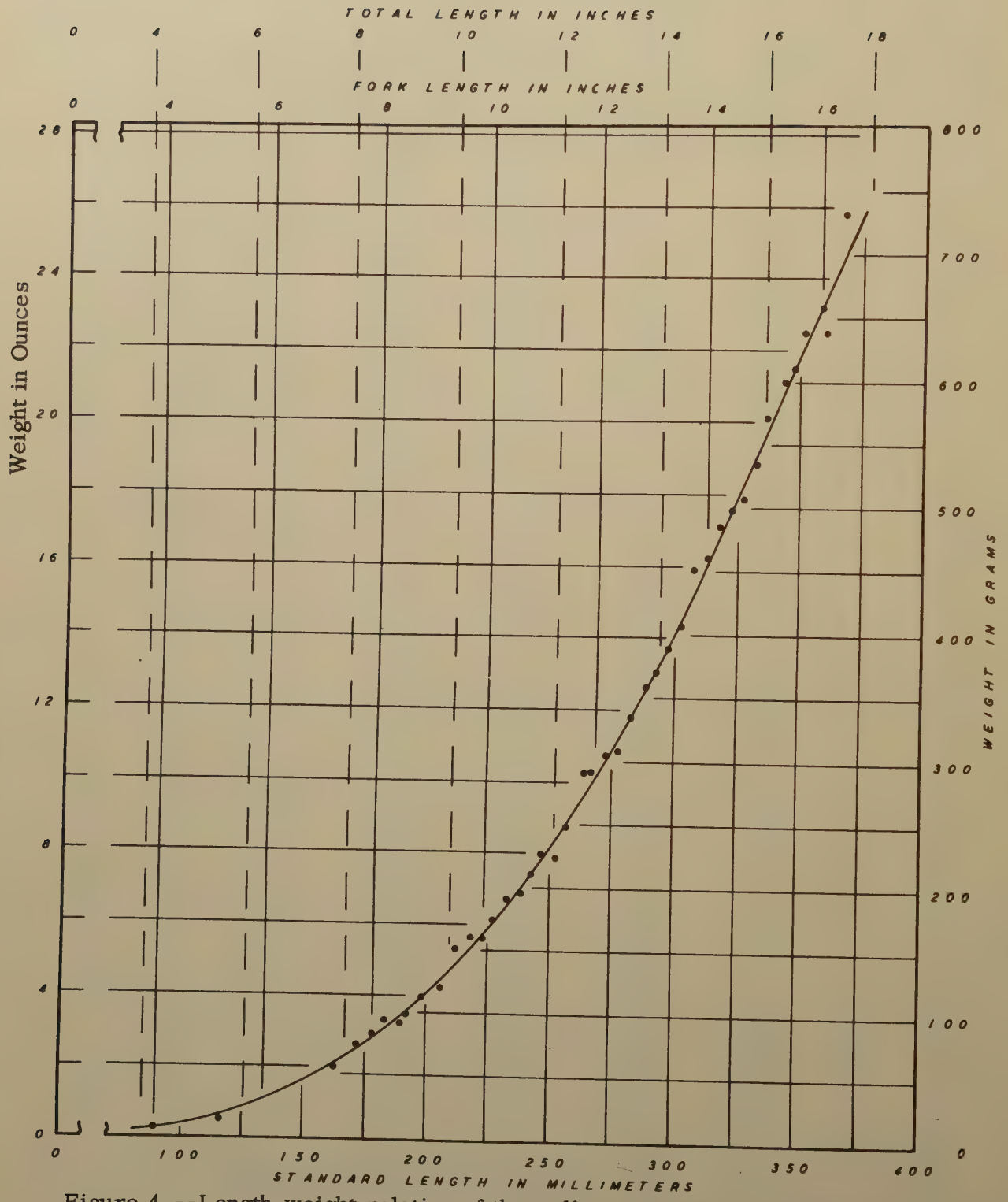

Figure 4.--Length-weight relation of the walleye of Lower Red Lake (data from table 14)

Table 15.--Number and percentage of mature and immature Red Lake walleyes by age groups.

Sex	Item	Age group							All age groups
		0	I	II	III	IV	V	VI	
Male	Number mature	-	0	1	11	54	14	1	81
	Number immature	-	8	19	13	4	3	0	47
	Percentage mature	-	0	5	46	93	82	100	63
	Percentage immature	-	100	95	54	7	18	0	37
Female	Number mature	0	0	0	2	38	61	3	104
	Number immature	1	8	24	18	17	9	1	78
	Percentage mature	0	0	0	10	69	87	75	57
	Percentage immature	100	100	100	90	31	13	25	43

whose average fork length was 14 inches (14.8 inches, total length) and whose average weight was 1 pound (table 10). However, nearly half (46 percent) of the males were mature as age-group III, whereas only 10 percent of the III-group females were mature. Apparently males tend to become mature at an earlier age than females. No well represented age group of either sex was composed entirely of mature fish.

Since nearly all of the II-group males were immature in August, it may be assumed that very few males of this group spawn when exactly 3 years old (in spring). Since nearly half the III-group males were mature in August, it may be assumed further that these fish were attaining sexual maturity for the first time at 4 years of age. Thus, if half the male walleyes are to be permitted to spawn once, they must be protected until their fifth summer; and if more than half are to spawn once, protection must be provided until the sixth summer. By a similar reasoning it may be determined that the majority of the females reach sexual maturity for the first time when exactly 5 years of age, and protection must be provided until they enter their sixth summer. These findings disagree with the statement of Surber (Minnesota Conservationist, February, 1934, p. 18) that walleyes mature in 3 years.

Table 10 indicates that males in their sixth summer (August) averaged 14 inches, fork length (15 inches, total length; 1.05 pounds) and the females 15 inches (15.9 inches, total length; 1.23 pounds). The average for both sexes combined was 14.8 inches, fork length (15.7 inches, total length; 1.2 pounds).

Data on percentage of maturity at different lengths (table 16) indicate that male walleyes mature at a smaller size as well as at a lower age in comparison with females. Although little difference exists between sexes in the length at which the first mature individuals occurred, a majority of the males were mature or maturing at all lengths beyond 280 millimeters, standard length, (12.5 inches, fork length) as compared with a length of 300 millimeters (13.4 inches, fork length) for females. Table 16 indicates that at 14 inches, fork length, 19 percent of the males and 36 percent of the females may still be immature. At 15 inches, fork length, all of the males and 89 percent of the females were mature.

To obtain adequate data on age and length of walleyes at first maturity, it was necessary to include both selected and unassorted samples in the tabulation. The inclusion of the data of selected fish causes the percentages of immature fish in the entire sample to be higher than would be expected in a strictly random sample of the commercial catch. In the unassorted sample of the commercial catch from 3-1/2-inch mesh nets, of a total of 47 males, 78 percent were mature; of a total of 80 females, 72 percent were mature.

Numbers of males and females in each age group and sex ratios were as follows: (The sex was not determined for one 0-group fish.)

Age group	Number of males	Number of females	Females per 100 males
0	0	1	-
I	8	8	100
II	20	24	120
III	24	20	83
IV	58	55	95
V	17	70	412
VI	1	4	400
0-VI	128	182	143

Among the younger age groups (I-IV) the representation of the sexes tended to be nearly equal. Females were strongly predominant, however, in age-groups V and VI. Females outnumbered males in the complete sample in the ratio, 143:100. (For sex ratios during the spawning season see table 22.)

Spawning habits and season

Walleyes of the Red Lakes spawn during the last half of April and early May and the eggs hatch in May and June. The actual dates on which spawning begins and ends vary somewhat in different years in accordance with weather conditions. The following list of dates when ripe eggs were collected for artificial propagation shows actual spawning dates in some years:

1932, April 19 to May 4; peak, April 22 to 28.

Table 16.--Number of mature and immature walleyes of Lower Red Lake and the percentage of mature individuals at different lengths.

Standard length in millimeters	Equivalent fork length in inches	Equivalent total length in inches	Males			Females		
			Number mature	Number immature	Percentage mature	Number mature	Number immature	Percentage mature
110-119	4.9-5.3	5.2-5.7	-	-	-	0	1	0
-	-	-	-	-	-	-	-	-
160-169	7.1-7.5	7.6-8.0	0	1	0	-	-	-
170-179	7.6-8.0	8.1-8.5	0	2	0	0	3	0
180-189	8.0-8.4	8.6-9.0	0	3	0	0	2	0
190-199	8.5-8.9	9.0-9.4	0	2	0	0	3	0
200-209	8.9-9.3	9.5-9.9	0	1	0	-	-	-
210-219	9.4-9.8	10.0-10.4	0	2	0	0	3	0
220-229	9.8-10.2	10.4-10.9	0	6	0	0	8	0
230-239	10.2-10.6	10.9-11.4	0	3	0	0	4	0
240-249	10.7-11.1	11.4-11.8	0	1	0	0	7	0
250-259	11.2-11.6	11.9-12.3	0	4	0	0	3	0
260-269	11.6-12.0	12.4-12.8	2	4	33	0	2	0
270-279	12.0-12.4	12.8-13.2	2	9	18	1	7	12
280-289	12.5-12.9	13.3-13.7	6	4	60	3	8	27
290-299	12.9-13.3	13.8-14.2	21	1	95	0	7	0
300-309	13.4-13.8	14.2-14.7	20	0	100	7	4	64
310-319	13.8-14.2	14.7-15.2	13	3	81	9	5	64
320-329	14.3-14.7	15.2-15.6	10	1	91	23	1	96
330-339	14.7-15.1	15.7-16.1	4	0	100	24	3	89
340-349	15.2-15.6	16.2-16.6	2	0	100	17	4	81
350-359	15.6-16.0	16.6-17.0	-	-	-	17	2	89
360-369	16.0-16.4	17.1-17.5	1	0	100	3	1	75
All lengths	-	-	81	47	63	104	78	57

1933, April 21 to May 8; peak, April 26 to 30.
1935, April 21 to May 8, peak, April 30 to May 2.
1936, April 19 to May 10; peak, April 30 to May 5.
1937, April 28 to May 11; peak, May 3 to 9.
1938, April 12 to 27; peak, April 16 to 26.

The principal spawning grounds are in Tamarack River and Shotley Brook which flow into the eastern end of Upper Red Lake and Black Duck River which enters the southeastern corner of Lower Red Lake. There are other spawning streams of minor importance. During periods of low water, as in 1935 and 1936, the walleye may spawn in the lake near shore if prevented from entering upstream spawning localities.

THE YELLOW PERCH OF LOWER RED LAKE

The yellow perch, Perca flavescens (Mitchill) ranks second to the walleye. The total production averaged 145,702 pounds annually from 1927 to 1938. In the period 1927-1938, yellow perch made up an average of 16.5 percent of the yearly catch. Because of the importance of yellow perch to the Red Lakes fisheries, those facts concerning the life history of the species obtained during the investigation are presented here.

Scale samples and data on length, weight, sex, and maturity were collected from 311 yellow perch, the total unassorted catch from 18 nets (5,400 linear feet). On the same day, August 24, scale samples and data were obtained from 196 "culls" sorted from the catch of all the remaining fishermen. Scale samples and data were also collected from 88 perch which were selected from catches made on August 25 to provide a more extensive range of sizes and age groups for study. Lengths only were recorded of 896 yellow perch, which, in addition to the 88 selected fish mentioned above, constituted the entire catches of yellow perch from 34 nets lifted on August 25.

Length-frequency distributions

With the yellow perch as with the walleye it is valid to base tabulations of the length-frequency distributions of the age groups (table 17) on the combined selected and unselected samples. Since inclusion of the selected fish distorted the data on the numerical representation of the age groups, a record of the age composition of the unselected sample of 311 fish has been included at the bottom of the table. The frequency distribution based on all unselected samples of the commercial catch (right of table) did not include the "culls" measured on August 24. This circumstance accounts for the fact that at certain lengths the totals for the age groups exceed the number of fish measured in all commercial samples. One of the 595 scale samples collected could not be used for age determination.

There was considerable overlap of the length-frequency distributions of the age groups, especially among the older and larger fish. Every length interval from 180 to 259 millimeters, standard length, was represented by at least 3 age groups, and some by 4, 5, or 6 age groups. In the unassorted samples of the commercial catch (right of table) the perch were concentrated between the lengths of 200 and 249 millimeters, standard length (9.0-11.2 inches, fork length; 9.4-11.8 inches, total length; 7.5-13.0 ounces), 90.0 percent of the total falling within that interval. This length interval of greatest abundance in the commercial catch corresponds with the lengths of greatest abundance of age-groups VI and VII. That these age groups were the best represented in the commercial catch is indicated also by the fact that age-group VI made up 60 percent and age-group VII 26 percent of the unassorted sample of 311 fish. The irregular nature of the frequency distribution of the smaller perch suggests that commercial gill nets may make a number of "accidental" captures (fish tangled in the webbing by their fins or mouth parts). The fact that the IV-group fish were poorly represented in both the selected and unselected samples may indicate poor survival in 1934.

Rate of growth

Examination revealed that inclusion of selected material with unselected did not alter average lengths and weights and calculated lengths of the age groups as determined from unselected samples alone. For purposes of a study of growth the data of both the selected and

Table 17.--Frequency distribution according to age groups and centimeter intervals of standard length of combined samples of yellow perch from Lower Red Lake.

Standard length (millimeters)	Equivalent fork length (inches)	Equivalent total length (inches)	Age group I	II	III	IV	V	VI	VII	VIII	I-VIII	Distribution in commercial catch: Number	Percentage
100-109	4.5-4.9	4.7-5.1	4	-	-	-	-	-	-	-	4	2	0.2
110-119	5.0-5.4	5.2-5.6	4	-	-	-	-	-	-	-	4	2	0.2
120-129	5.4-5.8	5.7-6.1	4	1	-	-	-	-	-	-	5	1	0.1
130-139	5.9-6.3	6.1-6.6	-	7	-	-	-	-	-	-	7	4	0.3
140-149	6.3-6.7	6.6-7.0	-	28	-	-	-	-	-	-	28	6	0.5
150-159	6.8-7.2	7.1-7.5	-	45	2	-	-	-	-	-	47	11	0.8
160-169	7.2-7.6	7.6-8.0	-	48	8	-	-	-	-	-	56	16	1.2
170-179	7.7-8.1	8.0-8.4	-	25	14	-	-	-	-	-	39	7	0.5
180-189	8.1-8.5	8.4-8.9	-	2	32	2	7	-	-	-	43	18	1.4
190-199	8.6-9.0	9.0-9.4	-	-	15	1	6	17	1	1	41	38	2.9
200-209	9.0-9.4	9.4-9.9	-	-	-	2	7	36	3	-	48	128	9.9
210-219	9.5-9.9	9.9-10.3	-	-	-	-	9	34	6	-	49	253	19.5
220-229	9.9-10.4	10.4-10.8	-	-	-	-	3	53	27	1	84	353	27.2
230-239	10.4-10.8	10.8-11.3	-	-	-	-	4	47	30	1	82	285	22.0
240-249	10.8-11.2	11.3-11.8	-	-	-	-	2	20	14	3	39	147	11.4
250-259	11.3-11.7	11.8-12.2	-	-	-	-	1	10	6	-	17	22	1.7
260-269	11.8-12.2	12.3-12.7	-	-	-	-	-	-	1	-	1	2	0.2
Combined unselected and selected samples (Total			12	156	71	5	39	217	88	6	594	Total number in above commercial sample = 1,295	
(Percentage			2.0	26.3	12.0	0.8	6.6	36.5	14.8	1.0	100.0		
Unselected sample only (Number			-	7	6	1	23	187	82	5	-		
(Percentage			-	2.3	1.9	0.3	7.4	60.1	26.4	1.6	-		

Note: At right of table is the length distribution of unassorted samples of the commercial catch, and at the bottom is the age composition of an unselected sample of the commercial catch.

unselected fish may be combined. Accordingly, table 18, which contains average lengths and weights at time of capture and coefficients of condition, K, for the males and females and for the sexes combined, and table 19, which contains calculated growth histories of the age groups and grand average calculated growth, have been based on all fish for which age determinations were made. All individuals of age-group I and nearly all of age-groups II, III, and IV were selected whereas from 59 percent (age group V) to 93 percent (age-group VII) of the fish of the remaining age groups were unselected.

The differences between lengths and weights of male and female yellow perch of age-groups I, II, and III were small and probably of little significance. On the other hand, lengths and weights of males and females of age-groups V-VIII are indicative of a possible sex difference in growth rate inasmuch as the females of each age group averaged longer and heavier than the males of corresponding age.

Calculated lengths at the end of the first year of life (table 19) of the various age groups were in good agreement among the older age groups. Calculated lengths for the first year of the I-group fish were greater than those of other age groups (except the single male of age-group VIII). The 12 yearling fish probably represented the larger and faster growing fish of their age group. Likewise, first-year calculated lengths of the II-group fish tended to be higher than those of the majority of the older age groups, probably for the same reason. Second-year calculated lengths of the II-group fish were also higher than average, which lends support to the inference that these were representative of only the larger, more rapidly growing individuals of the age group. Inclusion of age-groups I and II in the computation of the general growth curve does not have a significant distorting effect on the data. Among the older age groups agreement of the calculated lengths was satisfactory when the number of specimens was adequate.

The grand average calculated lengths at the bottom of table 19 are averages of the corresponding calculated lengths of the age groups for the first 4 years of life. Beyond the fourth year grand average calculated lengths were determined by the successive addition of the grand average increments of growth in length. This procedure made possible a natural "smoothing" of the growth curve in the later years. The graphical representation of the general growth (fig. 5) has been arranged to permit ready conversions between standard lengths in millimeters and total lengths in inches. The increments of growth in length are shown by broken lines. The increments show that most rapid growth of both sexes took place in the second year. A progressive decline in annual growth occurred after the second year, although growth of the third year still exceeded that of the first.

Calculated lengths of females of different age groups were slightly larger than those of males in all corresponding years of life. This indication of a distinct sex difference in growth rate is apparent in grand average calculated lengths. A similar sex difference in growth rate has been found in other perch populations, notably in Lake Erie (Jobes, 1952).

Length-weight relation and coefficient of condition

Length-weight data of Lower Red Lake yellow perch are presented in table 20 and figure 6 for each sex and for the sexes combined. In the table each length represents the average of all fish in a 5-millimeter interval of standard length. The curve of figure 6 has been constructed so that it may be read in terms of standard lengths in millimeters and weight in grams, or fork or total length in inches and weight in ounces. The length-weight data manifested no consistently large sex differences over the entire length range, although males of intermediate length (172 to 198 millimeters) were noticeably heavier than females of the same length.

The coefficient of condition, K, has been calculated for the averages of length and weight of fish within each 5-millimeter interval of standard length (table 20). The values of K of males may be described as relatively low over the length range of 108 to 168 millimeters, relatively high for lengths of 172 to 232 millimeters, and

Table 18.--Lengths, weights, increments of weight and coefficients of condition, K, of yellow perch from Lower Red Lake.

Age group	Sex[1/]	Number of fish	Standard length (millimeters)	Fork length (inches)	Total length (inches)	Weight (ounces)	Increment of weight (ounces)	Weight (grams)	K
I	M	6	114	5.2	5.4	1.1	-	32	2.16
	F	6	115	5.2	5.4	1.2	-	35	2.30
	M, F	12	114	5.2	5.4	1.2	-	34	2.30
II	M	34	156	7.0	7.4	3.1	2.0	87	2.29
	F	122	159	7.2	7.5	3.3	2.1	94	2.34
	M, F	156	159	7.2	7.5	3.3	2.1	93	2.31
III	M	36	182	8.2	8.6	5.1	2.0	143	2.37
	F	35	181	8.2	8.5	4.9	1.6	140	2.36
	M, F	71	182	8.2	8.6	5.0	1.7	142	2.36
IV	M	5	196	8.9	9.3	6.8	1.7	193	2.56
V	M	26	200	9.1	9.5	7.4	0.6	211	2.64
	F	13	229	10.3	10.8	10.2	-	289	2.41
	M, F	39	210	9.5	9.9	8.4	-	237	2.56
VI	M	91	210	9.5	9.9	8.7	1.3	247	2.67
	F	126	232	10.5	10.9	11.0	0.8	312	2.50
	M, F	217	223	10.1	10.5	10.0	1.6	285	2.56
VII	M	13	215	9.7	10.2	9.5	0.8	269	2.71
	F	75	234	10.6	11.0	11.5	0.5	325	2.54
	M, F	88	231	10.4	10.9	11.2	1.2	317	2.57
VIII	M	1	195	8.8	9.2	7.2	-2.3	206	2.78
	F	5	239	10.8	11.3	12.4	0.9	350	2.56
	M, F	6	232	10.5	10.9	11.5	0.3	326	2.61

[1/] M=male; F = female.

Table 19.--Length (in millimeters) of each age group of yellow perch from Lower Red Lake, calculated growth histories of age groups, and grand average calculated lengths and increments of length for all age groups combined.

Age group	Sex 1/	Number of fish	Actual standard length	Calculated length at end of year of life							
				1	2	3	4	5	6	7	8
I	M	6	114	52	-	-	-	-	-	-	-
	F	6	115	54	-	-	-	-	-	-	-
	M, F	12	114	53	-	-	-	-	-	-	-
II	M	34	156	48	116	-	-	-	-	-	-
	F	122	159	48	114	-	-	-	-	-	-
	M, F	156	159	48	115	-	-	-	-	-	-
III	M	36	182	43	96	152	-	-	-	-	-
	F	35	181	41	91	148	-	-	-	-	-
	M, F	71	182	42	94	150	-	-	-	-	-
IV	M	5	196	44	92	142	177	-	-	-	-
V	M	26	200	44	97	137	170	191	-	-	-
	F	13	229	46	105	155	195	221	-	-	-
	M, F	39	210	44	99	143	179	201	-	-	-
VI	M	91	210	43	95	141	171	189	203	-	-
	F	126	232	45	102	150	184	206	224	-	-
	M, F	217	223	44	99	146	179	199	215	-	-
VII	M	13	215	43	95	136	166	186	199	210	-
	F	75	234	49	97	143	178	198	213	227	-
	M, F	88	231	44	97	142	176	196	211	224	-
VIII	M	1	195	52	88	116	139	152	166	180	190
	F	5	239	42	93	140	168	187	205	220	233
	M, F	6	232	44	92	136	163	181	199	213	226
Grand average calculated length 2/	M	-	-	44 (212)	99 (206)	142 (172)	170 (136)	189 (131)	203 (105)	214 (14)	224 (1)
	F	-	-	46 (382)	104 (376)	148 (254)	182 (219)	203 (219)	220 (206)	234 (80)	247 (5)
	M, F	-	-	45 (594)	102 (582)	145 (426)	178 (355)	198 (350)	214 (311)	227 (94)	240 (6)
Average annual increment of length	M	-	-	44	55	47	31	19	14	11	10
	F	-	-	46	58	49	35	21	17	14	13
	M, F	-	-	45	57	48	34	20	16	13	13

1/ M = male; F = female.

2/ Number of specimens in parentheses; beyond the fourth year of life grand average lengths were determined by successive addition of grand average annual increments of length to grand average calculated length at the end of the fourth year of life.

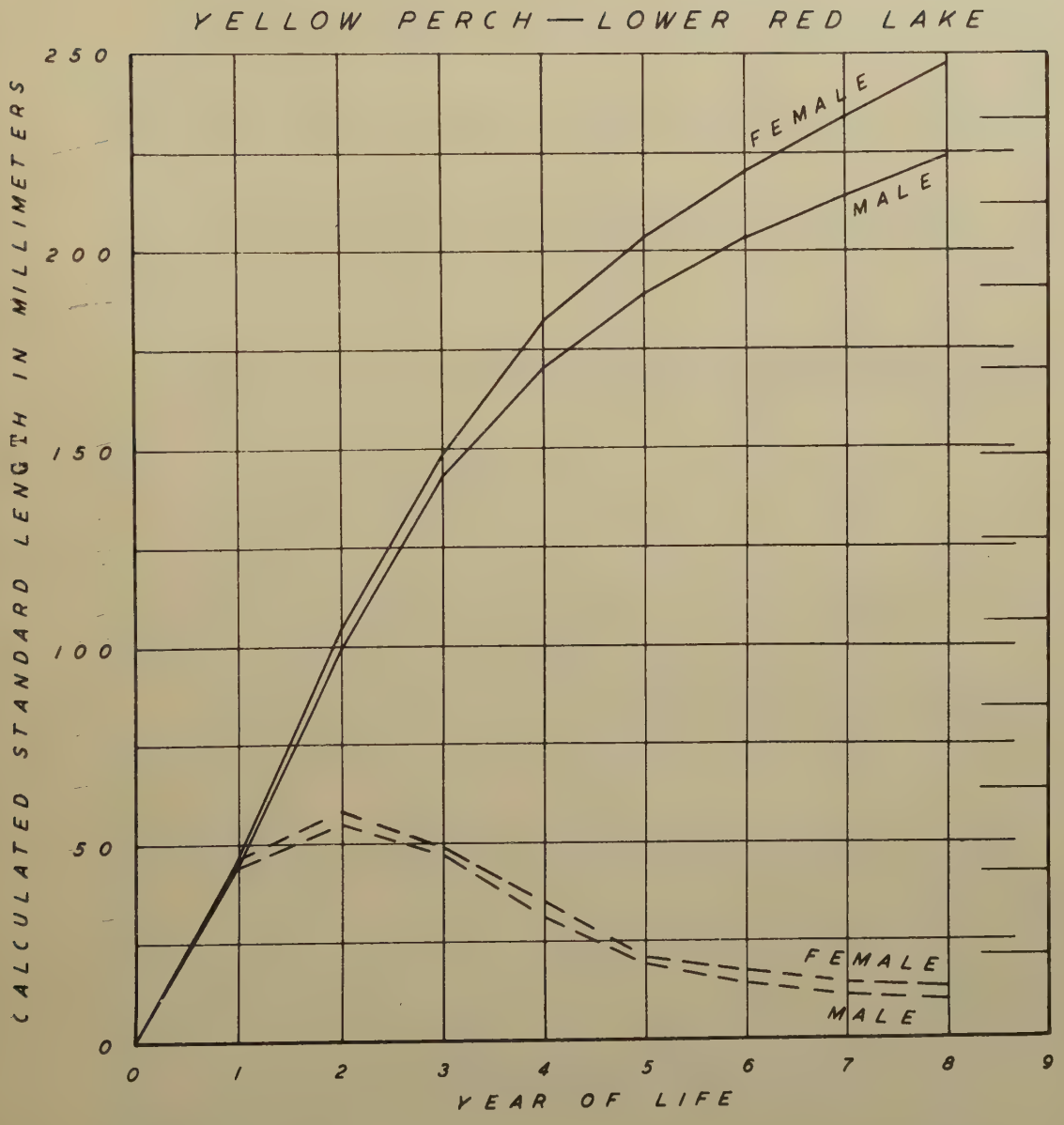

Figure 5.--Calculated lengths at the end of each year of life (continuous lines) and annual increments of length (broken lines) of male and female yellow perch from Lower Red Lake (data from table 19).

Table 20.--Length-weight relation and coefficient of condition of Lower Red Lake yellow perch (for each sex and sexes combined)

Male				Female				Sexes combined						
Standard length (millimeters)	Weight (grams)	K	Number of fish	Standard length (millimeters)	Weight (grams)	K	Number of fish	Standard length (millimeters)	Weight (grams)	Fork length (inches)	Total length (inches)	Weight (ounces)	K	Number of fish
108	21	1.67	2	108	35	2.78	2	108	28	4.9	5.1	1.00	2.24	4
112	32	2.28	2	111	21	1.53	1	112	28	5.1	5.3	1.00	2.01	3
-	-	-	-	118	35	2.13	1	118	35	5.3	5.6	1.25	2.13	1
122	43	2.37	2	122	43	2.37	2	122	43	5.5	5.8	1.50	2.37	4
-	-	-	-	129	43	2.00	1	129	43	5.8	6.1	1.50	2.00	1
-	-	-	-	134	50	2.08	1	134	50	6.0	6.3	1.75	2.08	1
138	57	2.17	1	138	58	2.21	5	138	58	6.2	6.5	2.04	2.21	6
142	71	2.48	1	142	68	2.37	9	142	68	6.4	6.7	2.40	2.36	10
147	70	2.20	7	147	75	2.36	11	147	73	6.6	6.9	2.58	2.29	18
151	74	2.15	5	153	83	2.32	16	153	81	6.9	7.2	2.85	2.28	21
158	93	2.36	8	156	87	2.29	18	157	89	7.1	7.4	3.14	2.30	26
162	93	2.19	6	162	95	2.23	24	162	94	7.3	7.6	3.33	2.21	30
168	109	2.30	8	167	107	2.30	18	167	108	7.5	7.9	3.80	2.30	26
172	128	2.52	3	172	120	2.36	17	172	122	7.8	8.1	4.29	2.38	20
178	135	2.39	5	177	130	2.34	14	177	131	8.0	8.3	4.63	2.35	19
182	145	2.41	15	183	130	2.12	5	182	141	8.2	8.6	4.98	2.33	20
187	162	2.48	14	187	160	2.45	9	187	162	8.4	8.8	5.70	2.48	23
192	183	2.59	12	192	168	2.37	7	192	177	8.7	9.1	6.25	2.50	19
198	204	2.63	19	198	179	2.31	3	198	201	8.9	9.3	7.09	2.60	22
202	226	2.74	29	-	-	-	-	202	226	9.1	9.5	7.97	2.74	29
208	242	2.69	18	209	291	3.19	1	208	245	9.4	9.8	8.63	2.73	19
212	252	2.64	16	212	234	2.46	7	212	246	9.6	10.0	8.68	2.58	23
218	268	2.59	14	218	278	2.68	13	218	272	9.8	10.3	9.61	2.64	27
222	283	2.59	17	222	281	2.57	35	222	282	10.0	10.5	9.93	2.58	52
225	301	2.64	2	227	297	2.54	30	227	297	10.3	10.7	10.48	2.54	32
232	310	2.48	3	232	312	2.50	41	232	312	10.5	11.0	10.99	2.50	44
238	312	2.31	2	237	332	2.49	35	237	331	10.7	11.2	11.68	2.49	37
-	-	-	-	242	342	2.41	24	242	342	10.9	11.4	12.07	2.41	24
248	354	2.32	1	247	363	2.41	15	247	363	11.2	11.6	12.80	2.40	16
-	-	-	-	252	376	2.35	13	252	376	11.4	11.9	13.25	2.36	13
-	-	-	-	256	395	2.35	4	257	395	11.6	12.1	13.94	2.34	4
-	-	-	-	260	411	2.34	1	260	411	11.8	12.3	14.50	2.34	1
Average and total	-	2.53	212	-	-	2.42	383	-	-	-	-	-	2.46	595

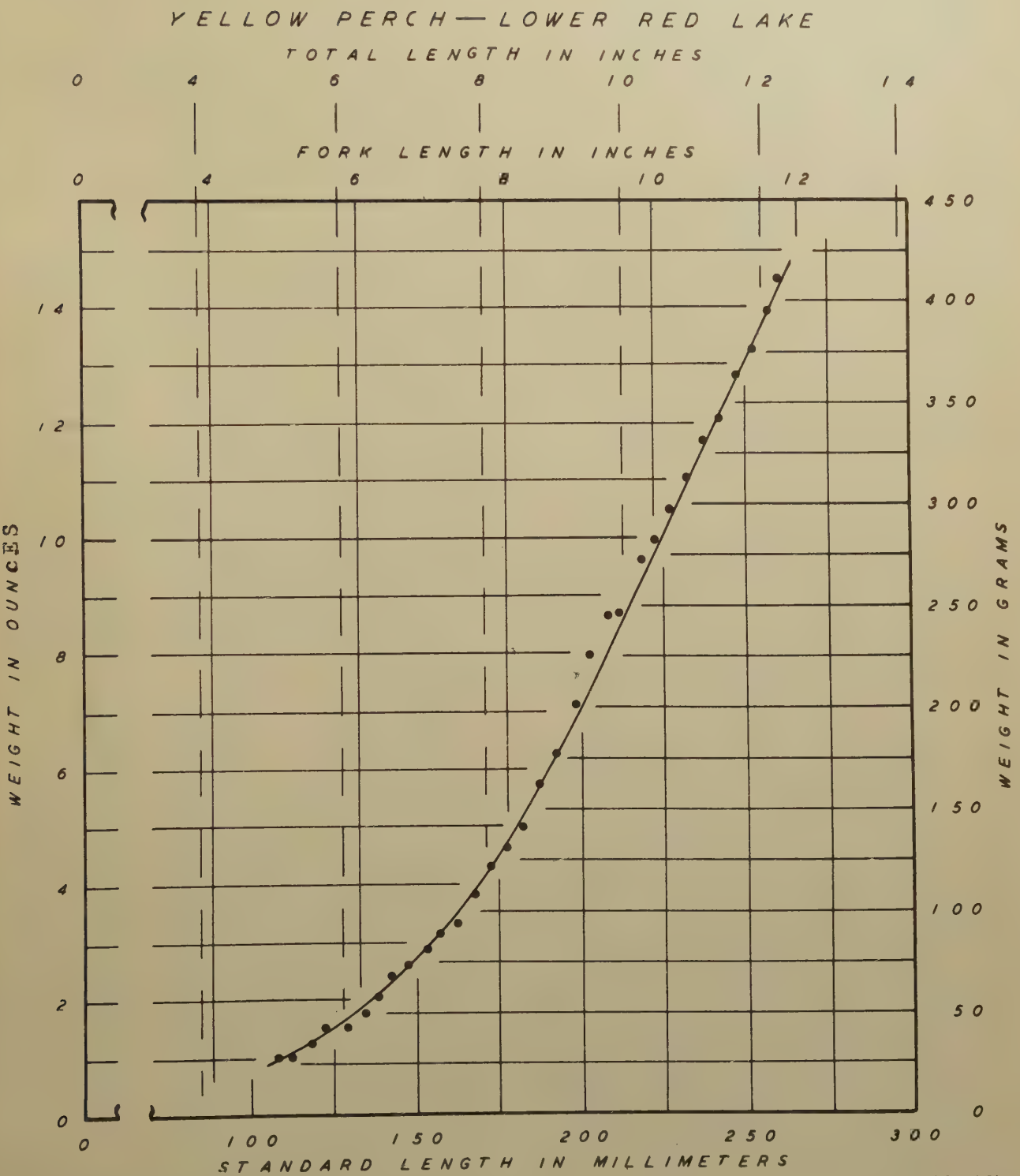

Figure 6.--Length-weight relation of Lower Red Lake yellow perch (data from table 20).

low again at lengths of 238 and 248 millimeters. There were wide fluctuations in the values of K within these different intervals of lengths. Females exhibited the same kind of change as males in values of K with increasing length of fish. However, the increase from a relatively low value of K to a higher value did not occur in the females until a length of 209 millimeters was reached, instead of 172 millimeters, and the decrease in coefficient of condition of larger females occurred at 242 millimeters instead of at 238 millimeters as in males. When data for the sexes are combined it may be seen that values of K remained at about the same level until a fish length of 172 millimeters was reached. The values of K increased over the length range of 172 to 202 millimeters, remained fairly constant at a high level for lengths of from 208 to 237 millimeters, then gradually declined with each increase in length of the larger fish.

The changes in the values of K with changes in standard length of sexes combined appear to be due to the trends in values of K of each sex. Each sex had approximately the same coefficient of condition at lengths of 108 to 168 millimeters, inclusive (K equalled 2.23 for the males, and 2.29 for the females). It is obvious that males were in better condition at lengths of 172 to 198 millimeters, inclusive. It is observed also that values of K for the sexes combined increased at the lengths where the males were relatively heavier than the females. The high value of K at 202 millimeters is due entirely to the heaviness of the males. The continued high value of K for the sexes combined at lengths of 208 to 232 millimeters no doubt was due to the circumstance that both sexes were in good condition at those lengths (K equalled 2.62 for the males, and 2.55 for the females). The high value of K at 237 millimeters for the sexes combined was due to the good condition of the females in that length interval and to the scarcity of the more slender males. Since both sexes showed a decline in condition at the greater lengths, the decreasing values of K at lengths of 242 millimeters and more was to be expected.

Values of K of individual age-groups (table 18) show only slight differences related to sex in the younger age groups but the males were distinctly heavier than the females in the older age groups (V-VIII). K showed a tendency to increase with age and length of the fish.

Average K of 2.46 for Lower Red Lake yellow perch is unusually large for the species and indicates that although they had grown at only a moderate rate for the species, they were extremely heavy for their length.

Maturity and sex ratio

The criterion employed to ascertain maturity in the walleye was also used for yellow perch. Male yellow perch of Lower Red Lake mature earlier than females (table 21). All fish of both sexes were immature as age-group I (in second summer). In age-group II, however, 59 percent of the males were mature whereas only 2 percent of the females were mature. The percentages of maturity for age-group III were: males, 94; females, 37. The samples contained no IV-group females but the high percentage of immature III-group females suggests that some would still have been immature as age-group IV. The IV-group males and all fish of both sexes of age-group V and older were mature. Sex ratios varied widely among the age groups, although the females tended to predominate. On the whole, the females outnumbered the males 180:100.

THE GOLDEYE OF THE RED LAKES

The goldeye, Amphiodon alosoides Rafinesque, was recorded as a separate item in the statistical summaries of the Red Lakes fisheries in 1917-1918, although thereafter, until 1927, it was grouped with the miscellaneous fishes. Goldeyes were reported to have been extremely abundant in the early years. Comparatively few goldeyes were sold until a demand developed for the smoked fish. In the period 1927-1938, an annual average of 57,876 pounds of goldeyes was marketed. This species accounted for 6.6 percent of the average annual catch of all fish. On the average, during 1930-1938, 97 percent of the yearly catch of goldeyes was produced during the summer season.

FRESHWATER DRUM OF THE RED LAKES

The freshwater drum (also called sheepshead, gray bass, and white perch), Aplodinotus grunniens Rafinesque, is one of the least valued of the commercial fishes of the Red Lakes. Large numbers are consumed fresh by the

Table 21.--Number and percentage of mature and immature yellow perch and sex ratios in the various age groups.

Sex	Item	Age group I	II	III	IV	V	VI	VII	VIII	All age groups
Males	Number mature	0	20	34	5	26	91	13	1	190
	Number immature	6	14	2	0	0	0	0	0	22
	Percentage mature	0	59	94	100	100	100	100	100	90
	Percentage immature	100	41	6	0	0	0	0	0	10
Females	Number mature	0	2	13	-	13	126	75	5	235 1/
	Number immature	6	120	22	-	0	0	0	0	148
	Percentage mature	0	2	37	-	100	100	100	100	61
	Percentage immature	100	98	63	-	0	0	0	0	39
Males	Total number	6	34	36	5	26	91	13	1	212
Females	Total number	6	122	35	0	13	126	75	5	382
	Females per 100 males	100	359	97	0	50	138	577	500	180

1/ The age of one mature female was not determined

resident Indians who also dry them in the sun or smoke them over campfires and store quantities of the dried or smoked product for winter consumption. They appeared separately in the statistics of the Red Lakes fisheries of 1917-1918, but thereafter until 1927, they were grouped with miscellaneous fishes. Over the period 1927-1938, an average of 18,592 pounds per year was caught. In 1930-1938, the only years for which catch statistics were separated by fishing seasons, 95 percent of the total catch of freshwater drum was made during the summer and 5 percent during the fall. Statistical records provide no estimate of the quantity caught for local consumption, but contain only a tabulation of the quantity marketed by the Red Lake Fisheries Association. The species is of little importance on the fresh-fish markets because of the rather coarse, dry quality of its flesh, and consequently it brings low wholesale and retail prices. Indians and others report the species is not as abundant as formerly, which is substantiated by the large catch (69,119 pounds) recorded for the years 1917-1918.

NOTES ON THE WHITEFISH

The whitefish, Coregonus clupeaformis (Mitchill), is the third most abundant species produced commercially in the Red Lakes; the average annual catch for 1927-1938 was 78,977 pounds. Catches from 1935 to 1938 were distinctly below normal, averaging only 31,912 pounds per year. Adverse weather conditions, low water levels, and frozen spawning grounds as well as a decrease in abundance may have been responsible. The majority of the whitefish catch comes from Lower Red Lake where in 1920-1928, 77 percent of the total catch of both lakes was obtained. In two of those years, however, (1920 and 1922) more whitefish were caught in the upper than in the lower lake. Whitefish are caught principally during the fall season; during 1930-1938, 82 percent of the total Red Lakes catch was obtained during the fall. During some years, however, high percentages of the total catch were made during the summer season, as in 1933, 1935, and 1936 when 50, 45, and 54 percent, respectively, of the annual yields were obtained by summer fishing.

NOTES ON THE NORTHERN PIKE

The northern pike, Esox lucius Linnaeus, ranked fifth in total production in the Red Lakes commercial fisheries up to the time of the survey. From 1927 to 1938 the annual catch averaged 24,714 pounds. The catches each year after 1932 were below average except in 1934. In 1923, 1924, and 1926-1928, 86 percent of the total yield of northern pike came from Lower Red Lake. In 1930-1938, 49 percent of the total production of northern pike was caught during the summer fishing season and 51 percent during the fall. Both large-mesh and small-mesh nets were fished in the fall, but their relative importance for production of northern pike is not known.

NOTES ON THE SUCKERS

The catches of white sucker, Catostomus commersonni (Lacépède), were not always recorded separately in statistics of the Red Lakes fisheries, but during some years were included with other species under the generalized heading of rough fish. All suckers were grouped together in the catch records for 1917-1918, 1927-1931, and 1933-1936. Besides the white sucker, the northern redhorse, Moxostoma aureolum was also included, although the former species probably comprised the bulk of the catch. During 1927-1938, the annual catch of suckers in the Red Lakes averaged 5,348 pounds.

THE ROCK BASS

The rock bass, Ambloplites rupestris (Rafinesque), is of minor importance in the Red Lakes and usually occurs only incidentally in the commercial gill-net catches. It is a game fish in Minnesota and, under the terms of state regulations, may be neither bought nor sold.

ARTIFICIAL PROPAGATION

Artificial propagation of Red Lakes fishes began in 1918 when an employee of the Minnesota Department of Conservation was

sent to the lakes to obtain walleye eggs. Only a small quantity was secured. The first whitefish eggs were collected during the fall of 1919. Because of the untrained personnel employed in 1922, only 13 percent of the whitefish eggs hatched. Experienced spawn collectors, sent to the Red Lakes in 1923, succeeded in obtaining 72,000,000 whitefish eggs that were shipped to the French River and Duluth hatcheries on Lake Superior for incubation. A loss of only 15 percent was reported (Surber, 1924).

A hatchery building was constructed at Redby, adjacent to the Minnesota State Fisheries buildings, in 1924. The water supply was obtained by impounding the waters of Mud Creek. The hatchery was equipped for incubation of the eggs of walleyes, whitefish, and trout. Its capacity in 1938 was 160 million eggs. The cost of the construction of the hatchery and the expenses of its operation in the years 1924-1928, were defrayed from the profits of the Minnesota State Fisheries. Over the period 1929-1938, a share of the salaries of 2 employees and a portion of the operating costs were borne by the Red Lake Fisheries Association, although the hatchery remained under the supervision of the Minnesota Department of Conservation.

Walleye

Eggs of walleyes hatched at Redby were obtained by the artificial spawning of ripe adults captured in pound nets set in three principal streams entered by spawning schools. Two of the streams, Tamarack River and Shotley Brook, flow into the eastern end of Upper Red Lake. (See fig. 1.) The third stream, Black Duck River, flows into the eastern end of Lower Red Lake. After 1933 there was no impoundment and stripping of walleyes in Shotley Brook (at least no records are available), as it proved to be the least productive of the 3 localities, and a more than adequate supply of eggs for the Redby and other hatcheries could be obtained readily from Tamarack and Black Duck Rivers.

The procedure of capturing walleyes was to set a pound net in the stream with the tunnel opening faced downstream and a wing extended at an angle to each bank. Four "dummy" pound nets, that is, cribs without tunnel or wings, constructed of the same kind of netting used for the pound-net crib, were placed upstream from the pound net to retain females not ready to be stripped at time of capture. The pound net was lifted each morning and the tunnel tied so no fish could enter. Ripe fish were spawned at once, and both males and females returned to the river above the pound net so that they could not re-enter it. Green females were placed in the "dummy" nets until they ripened, when they were spawned and released above the pound net. Because of this method of operation, it was possible to count the fish that ascended the streams. During the late afternoon the pound-net tunnel was untied and placed in position so fish could enter. Each day's recorded catch of male and female walleyes represented new arrivals taken during one night's fishing. In some years daily records were kept of males and females captured, females stripped, temperature of water and air, and weather conditions.

All available records of male and female walleyes captured annually in 3 spawning streams where egg-collecting stations were maintained are shown in table 22. The magnitude of the spawning run in Tamarack River far exceeded that in the other 2 streams. The consistently strong predominance of males (19 males to 1 female) each year appeared to be characteristic of spawning runs of walleyes in the Red Lakes.

The record of males and females captured does not provide a complete count of the spawning populations in the streams, and therefore, cannot be used as an index of abundance. Although the streams were blockaded effectively, fishing operations often were delayed until the main spawning run had started or were suspended before the close of the spawning season, as in 1932, 1933, and 1938. As soon as sufficient eggs for the Redby and other State hatcheries had been secured, the pound nets were removed. The collecting season did not always coincide with the spawning season, since in some years heavy runs were already underway when pound nets were first set. May 8, however, marks fairly well the termination of the normal spawning period.

Not only did the capacity of the hatcheries limit the take of walleyes and eggs in certain

Table 22.-- Walleyes captured by pound nets at spawning stations on the Red Lakes

Year	Tamarack River			Shotley Brook			Black Duck River			All localities				Period of collection			Remarks
	Males	Females	Total	Males	Females	Total	Males	Females	Total	Males	Females	Total	Percentage of males	First date	Last date	Number of days	
1932	192,236	8,898	201,134	35,487	2,951	38,438	31,420	1,415	32,835	259,143	13,264	272,407	95.1	April 19	May 4	16	Conditions normal; Upper Lake runs still strong on last date.
1933	430,430	17,742	448,172	5,991	2,064	8,055	88,784	2,745	91,529	525,205	22,551	547,756	95.9	April 21	May 8	18	Conditions normal; Tamarack run still strong on last date.
1/ 1934	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Low water; season a failure due to sudden change in temperature.
1935	-	-	1/-	-	-	1/-	7,028	465	7,493	-	-	-	93.8	April 21	May 8	18	Low water; run completed.
1936	109,820	4,970	114,790	-	-	2/-	91,578	3,232	94,810	201,398	8,202	209,600	96.1	April 19	May 10	22	Low water; runs completed.
1937	25,400	1,120	26,520	-	-	2/-	20,758	3,361	24,119	46,158	4,481	50,639	91.2	April 28	May 11	14	Low water and floods after operations began; runs completed.
1938	162,234	10,405	172,639	-	-	2/-	60,635	10,832	71,467	222,869	21,237	244,106	91.3	April 12	April 27	16	Conditions normal; runs still strong on last date.

1/ No record available.

2/ No fish captured or eggs collected.

years, but other factors such as low water levels, floods, sudden changes in temperature, and unfavorable weather conditions reduced the numbers collected in other years. For example, during the spring seasons of 1934, 1935, and 1936, the water level in Red Lakes was reported to be so low that many walleyes, especially the larger females, could not enter the streams to spawn. At its lowest stage, in 1936, the water at the mouth of Tamarack River was said to be only about 4 inches deep. At the same time, the depth at the mouth of Black Duck River was about 1 foot. By the spring of 1937, flood conditions in Tamarack River prevented proper setting of the pound net so the number of fish captured was small and the number of eggs collected unusually low.

Publications of the State of Minnesota report unfavorable weather conditions in the spring of 1924, 1930, and 1931; in addition to low water a sudden drop in temperature to almost winter conditions continued for such a long period in 1934 that upon resumption of favorable weather conditions the walleyes failed to return to spawn. A W.P.A. project approved in 1935 and carried through 1936, which made extensive channel improvements in Tamarack River, should prevent shallow-water conditions which impeded the spawning migration.

Again, the biennial reports of the Minnesota Department of Conservation state repeatedly that the number of walleye eggs taken depends to a large degree on reasonably uniform water temperatures. An examination of the daily temperature and catch records indicates that if such a correlation exists the relation is very general in character. Sudden changes in the abundance of fish occurred during the height of the season without a change in temperature, and vice versa -- sudden changes in temperatures occurred without affecting the trend in numbers of fish ascending the stream. Apparently a considerable latitude exists in temperatures that control movements of spawning walleyes. For example, large numbers ran in both Tamarack and Black Duck Rivers during April 22-30, 1936, when temperatures were low (mostly below 39°F., table 23). In fact, the largest number of fish (17,096) taken on Tamarack River in 1936 was caught on April 27, when the water temperature was 34°F. On the other hand, in 1937 large numbers were caught during May 2-8, when water temperatures were relatively high (mostly above 52°F.). However, the normal range of the temperatures during the main part of the spawning runs was 40°F.-48°F. and varied only from 5°F. to 8°F. (7 of the 11 runs).

All available records of the number of walleye females stripped, number of eggs obtained, and average number of eggs per female are contained in table 24. The calculation of the number of eggs collected is based on an actual count of 137,251 eggs per quart made in April 1938, by the superintendent of the Redby hatchery. The computation of the average number of eggs per female is low because the females were not subjected to sufficient pressure and manipulation to remove all the eggs and probably not more than 70 percent were expressed from the average female. The precaution against severe pressure is necessary to ensure that females will survive artificial spawning and will be in good physical condition and free from internal haemorrhage when returned to the water.

The first artificially hatched walleyes were deposited in the Red Lakes in 1919 when 560,000 fry were planted. (Table 25). Not until the Redby hatchery produced its first walleyes in the spring of 1925 were regular plantings begun. The tremendous variations in numbers of fry planted in different years were related to the differences in total number of eggs collected each year, number of eggs shipped to other state hatcheries, percentage of hatch, and number of fry produced at Redby used for stocking other waters.

Table 25 contains all available records on total number of walleye eggs collected and shipped from the Red Lakes, number of fry produced by the Redby hatchery, and number of fry planted in the Red Lakes. During 1932-1938, an average of 168,935,000 eggs was collected; the smallest number was taken in 1937 and the largest in 1938. On the average, about 35 percent of the eggs collected were shipped to other state hatcheries. Of the remaining 65 percent, about 57 percent were reared to fry stage at Redby. This percentage of survival does not substantiate Mr. Thaddeus Surber's statement (Minnesota

Table 23.--Water temperature (Fahrenheit) at Tamarack River (T) and Black Duck River (BD) egg-collecting stations during the walleye spawning season.

Date	1932		1933		1934		1935		1936		1937		1938		Average, 1932-1938	
	T	BD	T	BD	T[1]	BD[1]	T[1]	BD	T	BD	T	BD	T	BD	T	BD
April 12	-	-	-	-	-	-	-	-	-	-	-	-	44	-	44.0	-
13	-	-	-	-	-	-	-	-	-	-	-	-	44	44	44.0	44.0
14	-	-	-	-	-	-	-	-	-	-	-	-	46	44	46.0	44.0
15	-	-	-	-	-	-	-	-	-	-	-	-	45	46	45.0	46.0
16	-	-	-	-	-	-	-	-	-	-	-	-	44	45	44.0	45.0
17	-	-	-	-	-	-	-	-	-	-	-	-	42	44	42.0	44.0
18	-	45	-	-	-	-	-	-	-	-	-	-	42	42	42.0	43.5
19	44	45	-	-	-	-	-	-	37	-	-	-	40	42	40.3	43.5
20	48	45	-	-	-	-	-	-	37	36	-	-	38	40	41.0	40.3
21	46	49	39	37	-	-	-	34	34	36	-	-	40	38	39.8	38.8
22	54	49	39	39	-	-	-	34	34	34	-	-	38	40	41.2	39.2
23	59	47	42	41	-	-	-	37	37	36	-	-	42	38	45.0	39.8
24	41	46	44	41	-	-	-	38	38	37	33	-	44	44	40.0	41.2
25	41	46	44	42	-	-	-	40	35	36	33	-	46	46	39.8	42.0
26	38	45	45	42	-	-	-	42	36	38	33	-	44	-	39.2	41.8
27	39	46	46	41	-	-	-	44	34	38	34	-	46	-	39.8	42.2
28	43	47	45	42	-	-	-	45	39	40	42	40	-	-	42.2	42.8
29	47	49	45	43	-	-	-	46	38	38	42	42	-	-	43.0	43.6
30	46	49	42	42	-	-	-	44	41	40	41	44	-	-	42.5	43.8
May 1	43	50	43	41	-	-	-	40	41	42	42	45	-	-	42.2	43.6
2	46	52	46	40	-	-	-	39	40	42	46	48	-	-	44.5	44.2
3	44	-	45	41	-	-	-	40	45	43	49	52	-	-	45.8	44.0
4	47	-	43	42	-	-	-	40	46	44	52	54	-	-	48.2	45.0
5	46	-	47	43	-	-	-	43	46	44	52	58	-	-	47.8	47.0
6	-	-	48	44	-	-	-	45	48	48	53	58	-	-	49.7	48.8
7	-	-	47	45	-	-	-	45	56	54	54	59	-	-	52.3	50.8
8	-	-	48	-	-	-	-	47	54	56	52	59	-	-	51.3	54.0
9	-	-	-	-	-	-	-	-	52	57	-	56	-	-	52.0	56.5
10	-	-	-	-	-	-	-	-	50	57	-	56	-	-	50.0	56.5
11	-	-	-	-	-	-	-	-	-	-	-	56	-	-	-	56.0
Average	45.4	47.3	44.6	41.5	-	-	-	41.3	41.7	42.7	43.9	51.9	42.8	42.5	44.4	45.2
Number of days	17	15	18	17	-	-	-	18	22	21	15	14	16	13	-	-

[1] No data available.

Table 24.--Number of walleye females stripped and total and average eggs obtained from each female at spawning stations on the Red Lakes.

Year	Tamarack River			Shotley Brook			Black Duck River			All localities		
	Number of females stripped	Total number of eggs collected	Average number of eggs per female	Number of females stripped	Total number of eggs collected	Average number of eggs per female	Number of females stripped	Total number of eggs collected	Average number of eggs per female	Number of females stripped	Total number of eggs collected	Average number of eggs per female
1932	6,571	200,358,742	30,491	2,043	33,219,408	16,260	1,415	34,023,256	24,045	10,029	267,601,406	26,683
1933	1/ -	1/ -	-	1/ -	1/ -	-	2,745	89,284,900	32,526	2/ 2,745	89,284,900	32,526
1/1934	-	-	-	-	-	-	-	-	-	-	-	-
1935	1/ -	1/ -	-	1/ -	1/ -	-	435	7,822,717	17,983	2/ 435	7,822,717	17,983
1936	4,149	78,373,962	18,890	-	3/ -	-	3,229	23,744,421	7,353	7,378	102,118,383	13,841
1937	907	22,508,905	24,817	-	3/ -	-	2,818	36,920,549	13,102	3,725	59,429,454	15,954
1938	7,896	209,039,273	26,474	-	3/ -	-	5,898	146,964,280	24,918	13,794	356,003,553	25,809
Grand average	-	-	26,137	-	-	16,260	-	-	20,481	-	-	23,153

1/ No data available

2/ One locality

3/ No eggs collected

Table 25.--Walleye eggs collected and shipped from the Red Lakes, fry produced at Redby, and fry planted in the Red Lakes.

Year	Number of eggs collected	Number of eggs shipped by Redby hatchery	Number of fry produced at Redby	Number of fry planted in Upper Red Lake	Number of fry planted in Lower Red Lake	Number of fry planted in Both Lakes	Number of fry returned to Red Lake as percentage of Eggs collected	Number of fry returned to Red Lake as percentage of Fry produced
1919	-	-	-	-	-	560,000	-	-
1925	-	-	-	-	-	18,234,941	-	-
1926	-	-	-	-	-	10,900,000	-	-
1927	-	-	155,586,011	-	-	91,861,370	-	95.9
1928	-	-		-	-	57,324,641	-	
1929	-	-	196,430,546	-	-	120,204,590	-	89.2
1930	-	-		-	-	55,000,000	-	
1931	-	-	-	18,000,000	9,976,580	27,976,580	-	-
1932	267,601,406	-	-	24,480,000	59,930,200	84,410,200	31.5	-
1933	276,077,827	99,594,741	88,037,244	18,504,144	60,203,100	78,707,244	28.5	89.4
1934	60,798,200	12,026,339	21,602,780	10,286,040	7,989,802	18,275,842	30.0	84.6
1935	60,519,097	10,019,000	30,799,876	23,799,150	7,000,726	30,799,876	50.9	100.0
1936	102,118,383	10,000,000	61,532,036	-	-	56,133,783	55.0	91.2
1937	59,429,454	10,000,000	-	-	-	19,325,797	32.5	-
1938	356,003,553	176,000,000	110,500,200	-	-	104,500,200	29.4	94.6
Average	168,935,417	52,940,013	73,832,077	19,013,867	29,020,082	51,614,338	33.2	92.2

Conservationist, February 1934) that the usual survival is 75 percent, nor does it agree with percentages of hatch at the Federal hatchery at Lakewood, Vermont (46.7 percent), and by the State of Michigan on Saginaw Bay (35 percent).

On the average, 92 percent of the walleye fry produced at the Redby hatchery were planted in the Red Lakes. This represents an average yearly plant of about 51,614,000 fry. About 60 percent of these were planted in Lower Red Lake and 40 percent in Upper Red Lake, although the percentages varied greatly from year to year. The number of fry planted in the Red Lakes over the period 1932-1938 represented 33 percent of the eggs collected from these lakes, yearly percentages varying from 28 to 55. The number of fry planted, excluding 1919, varied from 10,900,000 in 1926 to 120,205,000 in 1929.

Whitefish

Artificially hatched whitefish fry were first planted in the Red Lakes in 1921, when 875,000 were introduced (table 26). The first collection of whitefish eggs from these lakes was made in the fall of 1919 when 2,000,000 eggs were taken. A regular program of artificial propagation of whitefish was begun in 1924 when the Redby hatchery was first placed in operation.

Eggs of Red Lakes whitefish were obtained by stripping fish captured by Indian fishermen in 5-1/2-inch mesh gill nets during the fall. After stripping, the fish were marketed. Those individuals with unripe eggs at the time of capture also were sold. Their sex products, therefore, were lost to the lake. Severe storms often interrupted the collecting of eggs. Mr. Thaddeus Surber (Minnesota Conservationist, December 1934) reported that during the fall of 1933 a change in weather conditions occurred so suddenly that it stopped abruptly the spawning run of the whitefish and destroyed many gill nets. He wrote: "In the whitefish operations where the eggs are procured through commercial fishing operations at Red Lakes, the fishermen themselves suffered a loss of 75 percent of their nets, the change was so sudden." In some other years exceptionally heavy winds prevailed and at times an early freeze-up occurred, such as happened in the fall of 1924 when the lakes froze a month earlier than usual and greatly limited the take of whitefish eggs. One Indian fisherman informed us that because of ice conditions, fishing for whitefish was profitable in only one out of three years.

For many years the Red Lakes were the only source of artificially propagated whitefish in Minnesota. Surber (1929) wrote: "The importance of maintaining the whitefish fisheries of Red Lake and of at least making an effort to restore, so far as possible, the same fishery in Lake Superior, has led this Department to spare no efforts to obtain all the eggs possible to meet this demand. Fortunately the vast resources of Red Lake have made it possible to secure large quantities of eggs, and while the quality of the eggs varies from season to season, we can at least be assured of maintaining the fisheries of Red Lake with a considerable surplus to divert to other waters, including Lake Superior." The statement reflects considerable optimism. In view of the decline in production of Red Lakes whitefish during years before 1938 (table 2), it appeared doubtful that the fry resulting from only a portion of the eggs collected from Red Lakes fish were particularly effective in maintaining the stock.

Optimism again was reflected in Surber's (1933) statement: "Our production of whitefish eggs continues to be of great importance. Not only are we maintaining an important fishery for this species in the waters of Red Lake but Red Lake has proven to be the only source from which we can expect a never failing supply of eggs for supplying other waters. From this source of supply we have successfully introduced whitefish into Lake Superior. This was responsible for the increased catch of whitefish in Lake Superior waters. We are procuring eggs of this species from Lake Superior which are readily identified as the Red Lake species." The principal distinguishing feature of the eggs according to Mr. Surber was a difference in average size, the eggs of the Red Lakes whitefish averaging 52,740 to the quart and those of the Lake Superior whitefish 35,000 to the quart.

It is questionable whether races of such a plastic form as the whitefish can be identified by a character as variable as the number of eggs per quart. The fact that the whitefish production of the Michigan waters of Lake Superior showed fluctuations corresponding to those of

the Minnesota production throws considerable doubt on the assumed causal relation between plantings of Red Lakes fry and commercial catch in Lake Superior. However, in more recent years immediately prior to 1938 there were more grounds for the belief that artificial propagation of whitefish was beneficial to the Red Lakes fisheries. If published reports describe the situation accurately, then the droughts or low water levels of several years (1931-1936) must have had a devastating effect on whitefish eggs deposited naturally in the lakes. The "Second Biennial Report, Fiscal Years 1933-1934"(1934) of the Minnesota Department of Conservation stated (p.164): "To those who have had occasion to study the real effects of the drouth however, the situation is more serious. To cite one instance, the water levels of Red Lake have receded to a point where the natural spawning beds of the whitefish are exposed to the open air and it is extremely doubtful if any natural reproduction will take place until the lake level has again attained its normal elevation. This is a serious matter because the whitefish of Red Lake is justly considered the most valuable food fish native to our waters." The "Third Biennial Report, Fiscal Years 1935-1936"(1936) reiterates the statement that the whitefish spawning beds "are all exposed" and "Naturally, if the eggs are deposited on these old beds, natural production is practically nothing, as the beds will be frozen solid throughout the winter." (p. 152). Under such conditions it is conceivable that artificial propagation might have been a factor in maintaining the whitefish of the Red Lakes.

Surber (1920) also reported that in 1918 burbot (Lota maculosa) were found on the whitefish spawning grounds with their stomachs filled with whitefish eggs. It is not believed, however, that burbot were numerous enough to have been a factor in the depletion of whitefish.

An incomplete record of whitefish eggs collected from the Red Lakes in the fall of various years over the period 1919-1934, appears in table 26. Although eggs were collected every year during this period, data were available to us for only 6 years. The computation of numbers of whitefish eggs collected was based on the accepted count of 47,000 eggs per quart. Only fragmentary data were available on the number of whitefish eggs shipped by the Redby hatchery crew to other hatcheries for incubation. Table 26 also contains data on the number of whitefish fry produced at Redby and planted in the Red Lakes. Since the published biennial reports of the Minnesota Department of Conservation indicate that practically all of the whitefish fry distributed by the State originated from the Red Lakes, data have been included showing the total number of whitefish fry produced by the State and the percentage of each yearly total produced at Redby and planted in the Red Lakes. Percentages of the number of fry planted in these lakes in the total number of eggs collected and in the number of fry produced at Redby are shown also.

Available records suggest an average of at least 45,586,000 whitefish eggs were collected annually from the Red Lakes from 1919 to 1938. Before the fall of 1924 and establishment of the Redby hatchery, all the eggs were shipped from the Red Lakes for incubation. Computations based on the scanty data for the years 1933-1935, indicate that on the average about 17 percent of the eggs collected by the Redby hatchery was shipped to other state hatcheries. The eggs retained at Redby yielded an average annual production of 37,411,064 whitefish fry, which represented a survival of about 62 percent as determined from the 1933-1935 data. This percentage hatch compares favorably with that obtained by the U. S. Fish and Wildlife Service and the State of Michigan (60-65 percent) for the same species. The number of whitefish fry produced at Redby represented two-thirds of the State's output of whitefish fry during 1927-1936. From 1921-1936, the State produced an average annual yield of 35,921,000 whitefish fry, and during 1921-1938 the State distributed approximately 550 million whitefish fry, nearly all, if not all, of which presumably came from the Red Lakes. Since 1920 a total of more than 461 million whitefish fry, or an average of 27,084,000 fry per year, was planted in the Red Lakes. This number represented roughly 43 percent of the eggs collected, 72 percent of the total production of whitefish fry in the State, and 97 percent of the fry produced at the Redby hatchery. Whitefish fry planted in the Red Lakes, excluding 1921, varied from 4,385,000 in 1925 to 59,210,000 in 1929. About 82 percent of the fry was planted in Lower Red Lake and 18 percent in Upper Red Lake.

Table 26.--Whitefish eggs collected and shipped from the Red Lakes, whitefish fry produced, and fry planted in the Red Lakes.

Year (Spring)	Number of eggs collected	Number of eggs shipped by Redby hatchery	Total number of fry produced by Minnesota	Number of fry produced at Redby	Percentage of State's output of fry produced at Redby	Number of fry planted in			Number of fry returned to Red Lake as percentage of		
						Upper Red Lake	Lower Red Lake	Both lakes	Eggs collected	Fry produced by State	Fry produced at Redby
1920	2,000,000	-	-	-	-	-	-		-	-	-
1921	10,000,000	-	1,971,334	-	-	-	-	875,000	8.8	44.4	-
1922	-	-	7,000,000	-	-	-	-	12,300,000	-	56.9	-
1923	-	-	4,058,000	-	-	-	-	-	-	-	-
1924	72,000,000	-	37,310,000	-	-	-	-	21,400,000	29.7	57.4	-
1925	-	-	-	-	-	-	-	4,384,520	-	-	-
1926	-	-	8,004,612	-	-	-	-	8,004,612	-	100.0	-
1927	-	-	81,563,434	80,215,424	69.8	-	-	46,365,424	-	56.8	95.2
1928	-	-	33,427,865			-	-	30,000,000	-	89.7	
1929	-	-	167,183,005	115,157,291	68.9	-	-	59,210,351	-	68.9	100.0
1930	-	-				20,900,000	35,046,940	55,946,940	-		
1931	-	-	-	-	-	10,000,000	42,398,960	52,398,960	-	-	-
1932	-	-	-	-	-	None	27,188,500	27,188,500	-	-	-
1933	83,831,800	16,407,756	54,393,360	43,893,360	80.7	3,511,469	40,381,891	43,893,360	49.4	80.7	100.0
1934	15,143,660	None	10,714,910	10,714,910	100.0	4,140,000	3,914,910	8,054,910	53.2	75.2	75.2
1935	85,539,798	16,068,630	53,650,169	42,613,169	79.4	3,120,000	39,493,169	42,613,169	49.8	79.4	100.0
1936	-	2,000,000	7,699,095	4,399,095	57.1	-	-	4,399,095	-	57.1	100.0
1937	-	1,000,000	-	-	-	-	-	6,687,554	-	-	-
1938	-	14,000,000	-	39,706,330	-	-	-	36,706,330	-	-	92.4
Average	45,585,876	8,246,064	35,921,214	37,411,064	66.6	6,945,245	31,404,062	27,084,043	43.0	71.9	97.2

Note: (The years are those in which the fry were planted and eyed eggs shipped; all of the eggs were collected and green eggs shipped in the fall of the preceding year).

Brook, brown, rainbow, and lake trout

Table 27 contains all available data on the number of trout and other varieties of fish, exclusive of the walleye and whitefish, planted in the Red Lakes and their tributaries or produced at the Redby hatchery during the spring of various years prior to 1938. According to the report of January 1, 1925 by the Superintendent of the Minnesota State Fisheries, the propagation and planting of all varieties of fry from 1917 to 1924 inclusive were carried on at the expense of the State Fisheries, about "90 percent of ...(whose) earnings have been derived from the Redby operation. ..."

Over the period 1917-1924, 621,150 brook trout fry were deposited in tributaries of the Red Lakes and 400,000 herring fry were planted in the Red Lakes. In 1927 and 1928 the Redby hatchery produced 104,940 lake trout fry, of which 43,611 or 42 percent were introduced into the Red Lakes. So far as known, no herring or lake trout were ever taken out of these lakes. During the 1927-1928 biennium approximately 15,000 perch fry were produced at the Redby hatchery. During 1927-1938 (3 years missing), this hatchery reared an annual average of 123,000 trout fry (brown, brook, and rainbow) which presumably were planted in the streams generally within a radius of about 75 miles from the Red Lakes. It may be safely assumed that since 1917 the Redby hatchery was largely responsible for the production of an estimated total of 2 million trout fry intended for anglers.

SUMMARY

1. The Red Lakes are situated in Beltrami and Clearwater Counties, Minnesota. All of Lower Red Lake and 49 percent of Upper Red Lake lie within the Red Lake Indian Reservation. Upper Red Lake has an area of 188 square miles and Lower Red Lake an area of 255 square miles. Both are single-basin, comparatively shallow, eutrophic lakes well suited for the production of fish. No limnological survey has been made of the Red Lakes.

2. An account of the commercial fisheries of the Red Lakes traces the development of the industry from its inception in 1917 as a war measure to augment food resources, through the period of State operation from 1919 to 1928, both years inclusive, and the period of cooperative management by the Red Lake Fisheries Association, Inc., from 1929 through 1938. Essential extracts from Minnesota laws, Federal regulations, and other documents are included.

3. A list of the commercial and non-commercial fish fauna of the Red Lakes, compiled from publications and new collections, includes 29 species of 25 genera and 14 families. Nineteen species, principally small forage fishes, had not been reported previously.

4. Statistics of the total catch for 20 years (1918 and 1920-1938) were analyzed. An average annual yield of 820,320 pounds of all species was secured with an average value of $49,644. Production in 1927, 1928, 1930, and 1933-1936 was below average, and in 1929, 1931, 1932, 1937 and 1938 was above average.

5. Walleyes, yellow perch, whitefish, goldeye, and northern pike predominated in the total annual production in the order named. The trend of the annual production of walleyes and yellow perch followed the trend of the total catch. Whitefish production was below average from 1935 to 1938.

6. Production statistics for Lower and Upper Red Lake were analyzed for 1920-1928. Ninety percent of the catch came from Lower and 10 percent from Upper Red Lake. In more recent years the yield from the upper lake was reduced considerably.

7. During 1927-1938, the Indians produced 95 percent of the total catch and white fishermen 5 percent.

8. On the average, 78 percent of the annual catch was obtained during the summer fishing seasons of 1930-1938, but 82 percent of the whitefish were caught during the fall season in those years. The summer catches included 80 percent of the annual yield of walleyes and 91 percent of the yellow perch.

9. During 1930-1938, an average of 200

Table 27.--Number of fry, exclusive of walleyes and whitefish, planted in the Red Lakes or their tributaries or produced by the Redby hatchery during the spring of various years.

Year	Species	Number of fry planted	Waters stocked	Year	Species	Number of fry produced at Redby
1917	Brook trout	17,250	Mud and Hay Creeks	1927)	Perch	15,000
				)	Brown trout	192,680
1918	Brook trout	85,500	Hay and Alcohol Creeks	)	Brook trout	132,799
1920	Brook trout	90,000	Battle River	1928)	Lake trout	104,940
1921	Brook trout	80,000	Battle River	1929)	Brown trout	133,260
				1930)	Brook trout	89,193
1922	Brook trout	220,000	Battle River	1933	Rainbow trout	112,500
1923	Brook trout	112,000	Battle River, Mill, Mud, and Little Rock Creeks	1934	Rainbow trout	110,342
1924	Brook trout	16,400	Battle River & Mud Creek	1934	Brown trout	72,006
1924	Herring	400,000	Red Lakes	1935	Rainbow trout	36,550
1927	Lake trout	6,126	Red Lakes	1936	Rainbow trout	78,353
1928	Lake trout	37,485	Red Lakes	1937	-	-
				1938	Trout (Brown, rainbow)	148,000
Average annual production of brown, brook, and rainbow trout combined -----						122,854

fishermen participated in the summer fishery each year and 174 in the fall fishery, and 223 fishermen took part at some time during the year. Indians comprised about 96 percent of the total number.

10. During 1930-1938, an average of 7,669 net lifts was made, 77 percent in the summer and 23 percent in the fall. Each fisherman made 30 lifts in the summer and 10 in the fall. The summer season covered an average of 57 days.

11. Because of a maximum production limit of 650,000 pounds of the principal species, the number of individual lifts made by each fisherman and the length of the summer season usually were inversely related to the abundance of fish. When fish were numerous the summer season tended to be shortened and consequently the number of lifts reduced.

12. The catch per unit of effort (yield per individual lift of small-mesh gill nets) during the summer season was held to be the best index of the abundance of fish of commercial size. During 1930-1938, the walleyes were below average in abundance in 1930 and 1934-1936, and above average in 1931-1933 and 1937-1938; the yellow perch were below average in 1930-1931 and 1934-1936 and above average in 1932-1933 and 1937-1938. 1936 was a poor year but 1937 and 1938 were excellent for both species. These rapid fluctuations in catch per unit of effort in 1936-1938 were thought to be due to changes in water levels, in the condition of walleyes, in size of mesh of gill nets, and in natural abundance. The disturbing artificial factors made a convincing study of abundance impossible. A stabilized fishery is a requisite for such a study. Whitefish apparently have decreased in abundance from 1935 and northern pike from 1934 to 1938.

13. The age, growth, maturity, and condition of walleyes of Lower Red Lake were studied. Length frequencies showed that 38 percent of the walleyes in the commercial catch were below the established minimum size limit of 14 inches, fork length (1938). The commercial catches were dominated by individuals in the fifth and sixth years of life. A length of 14 inches to the fork of the tail was reached in about 5 years.

14. Age, growth, maturity and condition of the yellow perch of Lower Red Lake were studied. Length frequencies showed that 90 percent ranged between 9 and 11 inches, fork length. The collections were dominated by fish in the seventh year of life. Females grew more rapidly than males in each year of life.

15. A historical account of the artificial propagation of walleyes and whitefish on the Red Lakes is presented. A continuous program originated with the construction of a hatchery at Redby in 1924.

16. The method of collecting and stripping walleyes for spawn is described. Records were obtained of the number of spawning males and females taken and of the number of eggs collected. The females produced an average of 23,153 eggs. The quantity of fry returned to the Red Lakes varied from year to year in accordance with the number of eggs collected, the number of eggs and fry supplied to other hatcheries or waters, and the variations in the percentage of hatch. In 1933-1938 about 35 percent of the eggs collected were shipped to other hatcheries. On the average, 92 percent of the fry hatched at Redby were planted in the Red Lakes, which represented only 33 percent of the number of eggs collected.

17. The method of collecting and stripping whitefish for spawn is described. About 17 percent of the whitefish eggs collected on the Red Lakes were reported shipped to other hatcheries, but on the basis of the total amount of fry produced, the data suggest that about 33 percent of the eggs were shipped. Roughly 43 percent of the eggs collected were returned to the Red Lakes as fry. On the average, 97 percent of the fry hatched at Redby or 72 percent of the State's output were returned to the Red Lakes.

18. During 1927-1938, the Redby hatchery produced an average annual yield of approximately 123,000 brown, brook, and rainbow trout fry.

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